

# NAVAL POSTGRADUATE SCHOOL

## Monterey, California



## THESIS

**THE EFFECT OF GRADUATE EDUCATION ON THE  
RETENTION AND PROMOTION OF MARINE CORPS  
OFFICERS**

By

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March 2001

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**THE EFFECT OF GRADUATE EDUCATION ON THE RETENTION AND  
PROMOTION OF MARINE CORPS OFFICERS**

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Submitted in partial fulfillment of the  
requirements for the degree of

**MASTER OF SCIENCE IN MANAGEMENT**

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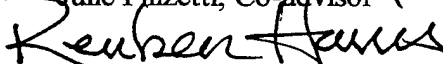
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## ABSTRACT

This thesis analyzes the factors associated with retention to the O-5 promotion point and selection for promotion to O-5. In particular, this thesis focuses on the economic returns to graduate education and specifically Naval Postgraduate School (NPS) education. In theory, the payoff to the Marine Corps is the increased productivity of the officer with a graduate degree. This thesis analyzes the differences in retention and promotion rates between officers with and without graduate degrees. Data from the FY1998 through FY2001 lieutenant colonel promotion boards and data for the corresponding accession cohorts, who entered the Marine Corps between FY1980 and FY1984 are merged with Automated Fitness Report System (AFRS) data. Nonparametric analysis and simple Probit techniques are used to estimate retention and promotion models. The results suggest that, in addition to other factors, graduate degrees from NPS and from sources other than NPS both have a positive effect on the retention and promotion of Marine officers. Several statistical techniques are applied to correct for potential biases due to self selection and sample selection. However, results from these techniques prove sensitive to slight changes in model specification and therefore, are not conclusive.

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## I. INTRODUCTION

The Marine Corps enters the 21<sup>st</sup> Century in the face of substantial changes in its operating, technological, and economic environments, all of which promise only uncertainty for the future. We conduct training in preparation for familiar military scenarios, but only education can prepare us for such an uncertain future. While efforts to increase the foundation of general education throughout the officer corps cannot guarantee victory on the modern battlefield, education can certainly improve the ability to adapt more quickly to the changing environment. In particular, graduate education for Marine Corps officers could enhance the foundation of intellect to provide a more productive, more versatile officer corps that is better prepared to lead and make decisions in an uncertain future and to adapt to the new environment. A recent National Academy of Sciences study (Volume 4: Human Resources of Technology for the United States Navy and Marine Corps, 2000-2035) describes the value of graduate education:

Graduate education provides career-long enhancement of the abilities of an officer, not just a technical specialty skill. Development of problem-solving skills is applicable to all kinds of problems that face the individual in unexpected situations. It is self-evident that there is little time for such education in wartime. The time to devote resources to obtaining graduate education is when the nation is at peace. It should be a high priority whose payoff is enhanced performance in times of war as well as in time of peace. Graduate education is a generator of future readiness with a high rate of return. (National Academy of Sciences 1997, 39)

Analysis of the Marine Corps' existing graduate education programs will provide insight into the incentives of individual officers to participate in and the incentives of the Marine Corps to support these programs. Based on the traditional economic assumption that rational individuals and organizations respond to incentives, the individual officer is

influenced by the effect of participation in graduate education programs on promotion to higher ranks as well as the potential earnings differential available in the private sector. Likewise, the Marine Corps is influenced by the difference in actual productivity between officers who participate in graduate education programs and those who do not as well as the difference in the retention rates of officers who participate and those who do not.

The economic theory of human capital suggests that a firm invests in the training and education of its workers and tries to ensure a return on that investment. This return can take the form of increased workplace productivity. In the case of the Marine Corps' investment in graduate education for its officers, the true returns in productivity are difficult to measure as officers with graduate education potentially make greater contributions to the combat readiness of the Corps, a concept that is difficult to measure. Traditional economic theory suggests that productivity is measured through level of pay. Since the military's pay system is not structured to reflect on-the-job productivity differences, alternate productivity indicators such as retention, performance reports and promotion must be used as quantitative indicators of the payoff from graduate education to the Marine Corps and to measure the return on investment.

#### **A. BACKGROUND**

The Marine Corps currently has three primary graduate education programs for its officers: the Life Long Learning (LLL) program, the Special Education Program (SEP) and the intermediate-level Professional Military Education (PME) institutions. All three programs serve different purposes and are administered by different organizations within the Manpower and Reserve Affairs Division at Headquarters Marine Corps and Marine Corps University.

Administered by Marine Corps Community Services (MCCS), the mission of the LLL Program is "to provide personal and professional learning opportunities to the Marine Corps community. The LLL Program positively impacts the recruitment, retention and readiness of active duty Marines and provides commanders with a valuable tool to prevent problems which detract from unit readiness." (MCO 1560.25C) One primary element of the LLL program is the Tuition Assistance (TA) Program, which provides officers and enlisted personnel with a 75 percent tuition subsidy to attend off-duty education at the same time they are fulfilling their normal military duties. In the case of officers, TA is only provided for enrollment in graduate or doctorate level programs. Participants can enroll in any degree field in any accredited, degree-granting educational institution. (MCO p1560.25C)

Perceptions of the LLL program are consistent with its mission statement in that the program is seen as more of a fringe benefit of military service than an investment in the Marine Corps' stock of human capital. A spillover effect of officer participation in off-duty graduate education programs could provide the Marine Corps with an officer who is more adaptable to changing environments, more prepared to think critically and able to provide deeper analysis than before his graduate school experience. In this regard, the Marine Corps' return on this program is somewhat irrelevant to the specific field of study chosen by the officer.

The LLL Program draws mixed reviews from the perspectives of the Marine Corps and the individual officers. From the organizational perspective, some recognize an increase in productivity from the officer with graduate education and benefits in the form of improvements in retention and recruiting. Others perceive off-duty graduate

education as a distraction from an officer's assigned duties for what is really a "stepping stone" to a lucrative job in the private sector. In that light, some view those programs as having a negative effect on retention. From the individual perspective, some Marines perceive off-duty graduate education as an opportunity to fulfill personal goals as well as make themselves more proficient officers. Others are apprehensive about participating because they perceive that participation could make them less competitive for promotion in the future.

Administered by the Officer Assignment Section, the Marine Corps' Special Education Program (SEP) is designed to provide qualified officers to fill the several hundred billets with a field-specific postgraduate education requirement. The SEP program primarily involves full time attendance at the Naval Postgraduate School (NPS) where officers receive full pay and benefits. The remaining officers receive graduate education from the Air Force Institute of Technology (AFIT). Officers assigned to SEP are not assigned any regular military duties during their studies, which last from one to two years. Officers assigned to SEP training are taken from the pool of officers available for assignment throughout the Marine Corps, thus some commands pay a price for the program in the form of unmanned billets. (MCO 1520.9F)

Education provided at the Naval Postgraduate School provides a mix of general and firm-specific education and training. Specific curricula are those that are specially tailored to suit the needs of the Naval Service and the U.S. military. Marine officers who attend the Naval Postgraduate School or AFIT typically spend five to six years away from "normal" career paths while they attend school and fulfill a payback requirement in a billet that requires both the general and firm-specific training and education. Officers

who return to their normal occupational fields after this time do so with a greater foundation of general education and a broader perspective of the big picture that, in principle, should contribute to their increased productivity.

Like the Voluntary Education Program, the SEP draws mixed perceptions about its utility to the Marine Corps. Some believe SEP is a stepping-stone to the private sector for those with career aspirations outside the Marine Corps. Others maintain a healthy appreciation for the expertise and critical analysis provided by SEP-educated officers. There is both anecdotal evidence and a common perception that SEP-educated officers get promoted to the rank of lieutenant colonel at lower rates than non-SEP officers.

In recent years, there has been an indication that these perceptions may be influencing officers' decisions to apply for SEP. While the Marine Corps traditionally holds one SEP board annually to select graduate school attendees from those volunteers with the greatest potential for promotion to the next rank, they have been forced to hold two boards annually for the last four years due to a shortage of applicants. The Marine Corps currently forecasts 14 vacant seats at NPS during the 2001-2002 academic year due to a shortage of applicants. Mark Brinkley from the Marine Corps Times highlights the possible reasons for this shortage:

The trouble, some officers say, is that Marines view the Naval Postgraduate School as a career-ending institution, a place to go if you want to get out of the Marine Corps and hope to set yourself up for a big money job outside. (Brinkley 2001, 16)

Most officers who volunteer for SEP do so with an understanding of the risks associated with these perceptions, and they are no less dedicated to their careers and no less loyal to the Marine Corps. This thesis will examine these perceptions and provide

evidence regarding the retention and promotion of SEP-educated officers compared to their peers.

Administered by Marine Corps University, the Marine Corps Command and Staff College (CSC) offers the opportunity to obtain a Master of Military Studies (MMS) for those who attend the full-time resident program provided they complete a thesis in addition to their standard curriculum. The mission of the CSC is to provide professional military education (PME) to field grade officers to prepare them for various duties with Marine Corps, joint and multinational military commands. (Marine Corps Command and Staff College 2000)

The Marine Corps also sends officers to equivalent intermediate-level PME schools from the Army, Navy and Air Force. The Army Command and General Staff College, the Naval War College and the Air Command and Staff College all offer degrees equivalent to the Master of Military Studies to their resident students. The education received at these PME institutions is firm-specific in nature and serves to enhance an officer's productivity within the military establishment. Completion of a resident or non-resident intermediate-level PME course is considered essential for promotion to the rank of lieutenant colonel in the Marine Corps; however, only those officers who attend the resident programs are eligible for the MMS degree. Acceptance into these resident programs is extremely competitive.

The Marine Corps' outlook on its graduate education programs is consistent with the 1975 House of Representatives, Committee on Appropriations Report regarding full-time training and education:



The Department of Defense does not have an obligation or mission to provide education or training beyond that which is required to maintain a professional military force. Education for the sake of education is not a function of the Department of Defense. (Mahon 1975, 54)

In discussion regarding the distinction between the requirements for professional military education and civilian graduate education, the Committee on Appropriations indicated that it did not value any spillover benefits from graduate education beyond validated, field-specific education requirements: "The point must be made that a master's degree is just an indication of civilian educational attainment and may or may not have relevance to the needs of the military services." (Mahon 1975, 61)

## **B. PURPOSE AND INTENT**

This research will develop the economic theory of human capital as it relates to the return to graduate education and Naval Postgraduate School education. The return on investment is based on differences in retention of Marine Corps officers and on promotion to the rank of lieutenant colonel for those with graduate degrees. The objective of the research is to derive accurate measures of effectiveness regarding the impact of graduate education in general and specifically of a degree from the Naval Postgraduate School. The outcomes are measured as the retention of Marine officers and the joint probability of retention and promotion to the rank of lieutenant colonel. Differences in these measures could be used as a basis in a future cost benefit analysis of the Marine Corps' graduate education programs.

Prior studies that evaluated the Marine Corps' return to graduate education focused on retention and promotion to the ranks of major through colonel; however, the studies that analyzed the effect of graduate education on promotion to lieutenant colonel and colonel were not based on entire accession cohorts since such data were unavailable.

Prior studies also did not analyze the change in returns to graduate education over time, which could reflect changing attitudes toward graduate education.

This thesis is unique in that it will analyze data from the 1998 through 2001 lieutenant colonel promotion boards. It will also use data from the accession cohorts that were commissioned between 21 December 1979 and 28 September 1984. These samples will be used as the basis for analyzing retention and the joint probability of retention and promotion to the rank of lieutenant colonel. The effects of graduate education on retention and promotion to the rank of lieutenant colonel are important since on average, Marine officers don't complete graduate education until after they have already been selected for the rank of major which is an up-or-out point in an officer's career.

### **C. ORGANIZATION OF THE STUDY**

Chapter II presents a review of the relevant prior literature regarding the effects of graduate education on the retention, performance and promotion of Marine Corps officers. The review covers general literature on the economics of education, military-specific graduate education models, and econometric methodology and selection bias issues. Chapter III addresses the various data sources, construction of analysis data sets and definitions of the analysis variables. Chapter IV discusses the descriptive statistics and preliminary analysis. Chapter V presents the econometric methodology and specification of the estimating models. Statistical results are also discussed. Chapter IV provides conclusions derived from the results, limitations to the analysis and recommendations for further research on the Marine Corps' graduate education programs.

## **II. LITERATURE REVIEW**

### **A. THE ECONOMICS OF EDUCATION**

The review of relevant literature regarding the impact of graduate education on retention and promotion of Marine officers should begin with discussion of the fundamental concepts relating to the economics of education. Such concepts include the economic theory of human capital, measurements of the benefits of education, labor market segmentation theory, and selectivity bias.

The economic theory of human capital refers to investment in human beings as assets that will provide income in the future, similar to investments in physical capital. As with physical capital, the costs of investment in human capital are compared to the expected flow of future income. Critics of the theory argue that educational achievement may simply serve as a signal of superior ability as opposed to actually increasing the level of knowledge and skill. (Woodhall 1987a)

Economists often conclude that a "weak" version of the "screening philosophy" is valid since many employers do use educational attainment as a screening tool. However, there is no evidence to suggest that education does not increase individual productivity. In his review of human capital concepts, M. Woodhall discusses the importance of the screening hypothesis:

The screening hypothesis serves as a reminder that education does far more than impart knowledge and skills. The reason why employers continue to prefer educated workers is that not only does the possession of an educational qualification indicate that an individual has certain abilities, aptitudes and attitudes, but the educational process helps shape and develop those attributes. (Woodhall 1987a, 23-24)

Investment in human capital generates benefits for the individual who participates and for society as a whole. The individual benefits from increased opportunities for employment and increased earnings. Individual costs include direct costs for tuition and books, and the opportunity cost of foregone earnings and leisure time due to the time spent on educational activities. Society also benefits from the increased productivity of its workers. Governments and corporations throughout the world recognize this return to society and subsidize all or part of the education costs for their citizens. (Woodhall 1987a)

In his 1987 essay "The Range of Educational Benefits" L.C. Solmon highlights the difficulty in assessing the benefits of an educational program. He acknowledges that economists tend to focus on readily measurable impacts, such as earnings differentials, while often overlooking the less obvious: "The problem is that numerous psychological, behavioral, cognitive, and effective impacts of schooling are very difficult to identify, and once identified, even more difficult to evaluate." (Solmon 1987, 85) He also highlights the difficulty of attributing all differences to educational achievement, since no two individuals in treatment and control groups are exactly alike and their true abilities and potential can never be measured. (Solmon 1987)

Economists share the fundamental assumptions that the predominant benefit of education is the increase in productivity and that the increased market earnings of the more educated worker reflect this increase in productivity. Productivity is reflected in a worker's increased efficiency and overall value to the employer. According to Woodhall, "classical and neoclassical economic theory assume that relative prices of goods and services and the relative wages and salaries of workers reflect their scarcity and hence, in

the case of workers, their productivity.” (Woodhall 1987b, 216) Since highly educated workers are more scarce than less educated workers, workers with higher levels of education receive greater salaries and wages. Thus, earnings differentials can be used to measure the economic return to educational attainment. (Woodhall 1987b)

Segmentation theory of labor markets suggests that the relationships between productivity and earnings are systematically different between the public sector, which includes the military, and the private sector. In his 1987 essay “Public Sector Employment and Education,” K. Hinchcliffe argues that a dominant characteristic of public sector employment is the internal labor market in which salaries and promotions are based not on individual productivity but rather on seniority, objective educational standards and “custom and practice.” Such criteria define “relative wages along job ladders rather than by reference to supply and demand.” (Hinchcliffe 1987, 225) In the internal labor market, educational qualifications serve as merely indicators of potential productivity and aptitude for training. (Hinchcliffe 1987)

Research regarding the economics of education is often questioned because of the potential for selection bias. Participation in educational programs that is not based on random assignment is affected by the personal choice of the participant as well as the choice of the educational institution. One can never truly know the potential earnings of a non-participant under the presumption that he did participate. Likewise, one can never know the true potential earnings of the participant had he not participated. Empirical research shows a consistent correlation between ability and years of schooling completed. Those with greater cognitive ability are more likely to voluntarily participate in and more likely to be selected for educational programs (Rosen 1987). According to R. Rosen

(1987), the only way to address the problem of selection bias is to construct models that reflect personal choice for participation in a given educational program.

## **B. STUDIES ON RETENTION AND PROMOTION OF MILITARY OFFICERS**

### **1. Study by Cymrot**

In his 1986 study "Graduate Education and the Promotion of Officers," Donald J. Cymrot argues that individual productivity in the military can be assessed by indicators such as performance evaluations, retention and promotion. Since officers are charged with greater levels of responsibility and receive higher salaries as they get promoted, promotion is an adequate indicator of productivity. His study used a logistic regression (LOGIT) model to evaluate the effects of fully-funded graduate education on the promotion of Navy officers.

Cymrot's study used cross sectional data from the 1985 Officer Master File to analyze the relationship between graduate education and promotion of officers to the ranks of O-4 through O-7. The data is restricted to those officers whose length of service is between 8 and 30 years. He recognizes a potential selection bias in his study, which results from the fact that his data do not contain records of officers who left active duty prior to 1985.

While the obvious explanatory variable in his model is graduate education, Cymrot also included variables for age, sex, race, time in grade for previous ranks, continuous active service and branch designation. Since selection for fully-funded graduate education is based on potential for promotion to the next rank, a positive coefficient of the graduate education variable does not necessarily demonstrate causality

due to potential selection bias. Cymrot included variables for time in previous grades and service continuity to correct for this selection bias.

Cymrot hypothesized that an officer who has such an outstanding record that he was selected for promotion to previous ranks ahead of his accession cohort must be more productive. His variables for time in previous grades serve as indicators of productivity at various points throughout an officer's career and should be unrelated to the impact of graduate education. Likewise, his service continuity variable was also used to control for the productivity difference associated with officers with continuous or interrupted active service.

The effect of graduate education on promotion was significant and positive for the ranks of O-4 through O-6 and not significant for promotion to O-7. The inclusion of adjustments for productivity, unrelated to graduate education, indicate that graduate education does increase the probability of promotion to the next rank. The marginal effects of having a graduate degree increase the probability of promotion to O-4 by 26 percent and promotion to O-5 by 10.5 percent. The time in grade at previous rank variables were negative and significant which indicate that the less time one spent in previous ranks, the more likely they were to be promoted to their current rank. Cymrot also found that the age variable (presumably age at commission) was significant in that older officers were more likely to be promoted than younger officers.

While Cymrot focused his study on the effects of graduate education on promotion alone, he acknowledged that his findings only partially identified the marginal productivity benefit of graduate education since he didn't analyze effects on productivity within given ranks or retention. Additionally, Cymrot did not attempt to correct for any

sample selection issues associated with question of whether or not an officer remained on active duty long enough to be considered by the promotion board. This issue presents another potential for bias in his findings for graduate education since his samples included only those officers who remained on active duty long enough to be considered for promotion.

## **2. Study by North and Smith**

In their 1993 study "Officer Accession Characteristics and Promotions to Captain and Major," North and Smith used an econometric technique called the bivariate probit with sample selection to assess the joint probability of whether or not on a Marine officer remained on active duty long enough to be considered for promotion to the ranks of captain and major and whether or not they were in fact promoted. The goal of their study was to isolate race and ethnicity effects on promotion rates of Marine officers while statistically controlling for other effects.

North and Smith used data from the Longitudinal TBS File and merged it with promotion data from the Headquarters Marine Corps Master File. The TBS Longitudinal File is maintained by the Center for Naval Analysis to track changes in an officer's record from the time of TBS throughout their career. Their data covered the entire accession cohort of officers commissioned between FY1980 and FY1991 as well as data on the FY1984 through FY1983 promotion boards for captain and FY1992 through FY1993 promotion boards for Major. Since analysis of promotion results was based on those who remained on active duty until the time of the selection board, they created two samples for each promotion category. The first sample consisted of the entire accession



cohort and the second consisted of only those who were considered in the primary zone at a given promotion board.

Their use of the bivariate probit with sample selection allowed them to correct for sample selection bias, which may result from unmeasured factors affecting retention that also affect the likelihood of promotion. North and Smith assumed that an officer's separation decision prior to a given promotion board was negatively related to their likelihood of selection for promotion. This technique required them to jointly estimate two equations: one for the likelihood of retention to each promotion board and a second for the likelihood of promotion among those who stayed to each board. They then determined the value of the rho term, which is the value of the correlation between the error terms of the two equations and assessed its significance; rho was statistically significant, which indicated the presence of a selectivity bias caused by unobserved factors correlated with both retention and promotion.

North and Smith's models included explanatory variables for personal characteristics that included race, age at accession, marriage at accession and prior service status. They also included variables to analyze the effect of occupational specialty based on the general military occupational specialty (MOS) categories of combat, aviation, ground support, aviation support and service. Finally, they considered the effects of accession source and year of promotion board since different promotion boards have different promotion opportunity and size.

North and Smith found that Naval Academy graduates and NROTC graduates were more likely to be promoted to the ranks of captain and major than officers from other accession sources. Officers who were married at the time of accession and aviators

were also more likely to be promoted than unmarried officers and officers from other MOS categories. North and Smith found that gender and GCT score were not statistically significant in the probability of promotion. While they found that black and other minority officers are less likely to be promoted to the rank of captain than white officers, they found that race was not a significant factor for promotion to major.

### **3. Study by Bowman and Mehay**

In their 1999 study "Graduate education and employee performance: evidence from military personnel," Bowman and Mehay examined the relationship between individual productivity and graduate education by analyzing the effect of graduate education on promotion to the rank of lieutenant commander in the U.S. Navy. Their study focused on promotion as the performance measure of interest although individual fitness report measures were also used as explanatory variables in their estimating models. A significant portion of their study was dedicated to the statistical correction of selectivity bias that comes with an individual's personal decision, and the Navy's selection of individuals to participate in funded graduate education programs. Bowman and Mehay used data from the Navy's Promotion History File and merged it with fitness report data for all line and staff officers considered for promotion to O-4 between 1985 and 1990 (roughly, year groups 1975 through 1980).

Bowman and Mehay specified a series of models to isolate the effect of graduate education on promotion. They included variables that demonstrated cognitive skill such as college GPA, a technical undergraduate degree and graduate education, and they included variables that demonstrated affective skills such as accession source. They also included the standard demographic characteristics such as race, sex and marital status.

Their first four models used the single stage probit technique. Each model increased the number of controls in order to isolate the effect of graduate education. The first model included only the demographic characteristics and graduate education; the second added the cognitive characteristics; the third added the affective characteristics; and the fourth added a measure of early performance evaluations. With the successive inclusion of controls, the marginal effects of graduate education on probability of promotion decreased by close to 40 percent from .098 to .065 and from .145 to .089 for line and staff officers, respectively.

In order to rid the error term of their model from any remaining correlation to possession of a graduate degree, Bowman and Mehay chose a two stage bivariate probit technique similar to that used by North and Smith (1993). They first estimated a probit model to assess the likelihood of graduate school acceptance and completion. In addition to the standard explanatory variables from their previous models, they added "instrumental variables" (omitted from their original single stage models) that reflected an officer's previous desire to undertake graduate education, undergraduate performance in math and science, and dummies for warfare community. Bowman and Mehay included the variables of desire for graduate education, undergraduate performance and warfare community in the graduate education selection model since they were theoretically related to selection for graduate education and not related to promotion to O-4.

The bivariate probit model required the joint specification of a second model that assessed the likelihood of promotion to O-4 and included all of the original explanatory variables from the single stage probit. The covariance of the error terms ( $\rho$ ) in the two models of the bivariate probit was also estimated.

The results of the bivariate probit showed that the rho term was statistically significant and that the coefficient of the graduate education variable had decreased in comparison to results from the simple probit model. This finding held true for individual models for line and staff officers (with fully-funded graduate degrees only and with graduate degree from any source). Thus, selectivity bias from unobserved factors that relate to both selection for graduate education and promotion do impart an upward bias on the graduate education coefficient in the promotion model. Ranging from .045 to .056 in the bivariate probit models, the marginal effects indicate that even after controlling for selectivity bias, officers with graduate education are more likely to be promoted to O-4 than officers without graduate education.

#### **4. Study by Wielsma**

In his 1996 Naval Postgraduate School thesis "An Analysis Of Factors Affecting Promotion, Retention and Performance For USMC Officers: A Graduate Education Perspective," Ronald J. Wielsma attempted to analyze the factors associated with promotion to O-4 (major), retention to the O-4 promotion point and actual performance ratings with specific emphasis on the effects of graduate education. While most studies on the factors affecting promotion simply evaluate data from the pertinent promotion board, Wielsma used longitudinal data from the FY1980 officer accession cohort, which allowed him to study the effect of graduate education on retention and the effect of graduate education on the joint probability of retention to the O-4 promotion point and selection for promotion.

Wielsma initially recognized the potential for self-selection bias and sample selection bias on his graduate education estimates. An officer's retention decision and

likelihood of promotion are likely affected by characteristics such as ability and taste that are unobserved and also impact their personal decision to attend graduate school. An officer's selection for promotion to O-4 is affected by their retention to the O-4 promotion point. The majority of Wielsma's study addressed the recognition and impact of such bias.

Wielsma first ran a simple probit model with promotion to O-4 as his binary dependent variable and used only the sample of those who remained on active duty until the promotion board. Consistent with Wise (1975), and Bowman and Mehay (1999), Wielsma organized his explanatory variables into cognitive traits, affective traits and demographic traits. His cognitive traits included graduate education, performance evaluation index, GCT score, and rank at TBS. Affective traits included MOS category, accession source, and enlisted service status. In this simple model he found that the effects of graduate education and the performance index were significant and positive.

To address the self-selection bias and sample selection bias, Wielsma chose the two stage Heckman Procedure (Heckman 1979). He first used the simple PROBIT to model the probability of selection for graduate education in order to derive an inverse Mill's ratio, which accounts for all unobserved effects still present in the error term. He also ran a simple PROBIT to model the likelihood of retention to the point of promotion in order evaluate impacts on retention as well as develop a second Mills' ratio. In his retention model he found graduate education, the performance index and marital status to be positive and significant. He found class rank at TBS and unemployment rate at time of separation to be negative and significant. According to Wielsma, unemployment rate was the most significant factor affecting retention.

In the second stage of the Heckman procedure, Wielsma included both Mills' ratios in his initial structural equation for promotion to O-4. He also used ordinary least squares (OLS) to evaluate the binary possibility of promotion. Not only did he find the coefficient of his second Mills' ratio (correction for the retention issue) to be negative and significant, he found the signs of graduate education, performance index and marital status became negative and significant. Additionally he found that pilots were more likely than officers from other MOS categories to be promoted and that Naval Academy and NROTC graduates were less likely than officers from other commissioning sources to be promoted. Since Wielsma used OLS (a linear function) to model the binary outcome of promotion (a non-linear function) in his second stage, the sign and significance of the coefficients can provide useful insights while the magnitude of the coefficients cannot because they are inconsistent.

## **5. Study by Long**

In his 1992 Thesis "Effect of Variables Independent of Performance on Promotion Rates to Major, Lieutenant Colonel, and Colonel in the Marine Corps," Peter Long attempted to identify the characteristics that affected promotion to the ranks of O-4 through O-6 in the Marine Corps. Long used historical, cross-sectional data for those officers in the primary promotion zone for the ranks of O-4 through O-6 during FY1986 through FY1992. Long did not use a performance evaluation measure in his research since such data were not available to him.

Using the logistic regression function, Long combined the data for the entire period from FY1986 through FY1992 to develop separate models for each rank. Long found that married officers, officers who had completed the appropriate level professional

military education (PME), and officers with graduate degrees were more likely to be promoted than unmarried officers, those without PME and those without graduate degrees. Long found the factors relating to race, sex and combat experience were not statistically significant for promotion to any rank.

## **6. Study by Estridge**

In his 1995 thesis "A Comparative Analysis Of Promotion Probabilities For Marine Corps Field Grade Officers With Special Attention Given to Graduates Of The Naval Postgraduate School," David Estridge attempted to identify those factors that most affected promotion to the ranks of O-4 and O-5 in the Marine Corps. Using data from the 1993 and 1994 promotion boards to O-4 and O-5, Estridge specifically focused on the effects of graduate education from NPS. Estridge claimed that selection for the SEP program, which predominantly consists of programs at NPS, was extremely competitive during the years that corresponded to his study.

Estridge developed a performance evaluation index by assigning values of each of the individual quality indicators and performance indicators on the fitness report. He then took the mean value of all of the observed marks for the quality indicators and performance indicators and added them together to achieve a final performance evaluation index. The value of his performance evaluation index ranged from 1 to 12, but his mean index yielded 11.78 and 11.66 for captains and majors, respectively, which indicated hyper-inflation of fitness report marks by reporting seniors.

Results of his logistic regression models indicate that accession source, MOS, number of personal awards and NPS graduation had a positive impact on promotion to the rank of O-4 and that race, accession source, personal awards and NPS graduation had

a positive impact on promotion to O-5. His performance evaluation index had the greatest impact on promotion to both ranks.

In his descriptive statistics, Estridge noted the differences in selection rates for NPS graduates over non-NPS graduates at close to 12 percent for O-4 and 0.3 percent for O-5. Even when other explanatory variables were held constant, NPS graduation proved to have a positive impact on promotion to both ranks. Estridge recognized the Marine Corps' stiff selection process for NPS: "the Special Education Selection Boards are simply doing a very good job in selecting officers to attend NPS – officers that probably would have been selected for major and lieutenant colonel regardless of their selection to attend the Naval Postgraduate School." (1995) Estridge made no attempt to correct for this selection process and the potential selection bias in his estimates.

#### **7. Study By Grillo**

In his 1996 Naval Postgraduate School Thesis "A Study Of Promotion To Major In The Marine Corps," Mark Grillo used a logistic regression model to estimate the effects of race and sex on promotion to O-4. Although race and sex were his primary focus, Grillo also evaluated the effects of other factors related to promotion such as graduate education, dependents, promotion zone classification and whether or not an officer's MOS was given special consideration in the board precept. Grillo used a performance evaluation index similar to those created by Wielsma (1996) and Estridge (1995). His data consisted only of the sample of officers considered for promotion to O-4 during the 1994 and 1995 boards. Hence he did not consider the retention effect based on the whole accession cohort. Grillo acknowledged that the limited scope of his data might reduce external validity since each promotion board has its own selection criteria.



Grillo hypothesized that since blacks were promoted at a 20 percent lower rate than whites, minority status should have a negative impact on promotion in his multivariate model. He hypothesized that graduate education and number of personal awards and performance evaluation index would have a positive impact on promotion.

Grillo used individual binomial logit models to estimate the effects on promotion to O-4 during the FY1994 and FY1995 boards. While Grillo did not discuss a combined model with both promotion boards, it is assumed that a log-likelihood ratio test indicated that the coefficients were statistically different for the two separate models. Although he found that the variables associated with race, sex, dependents and graduate education were not significant, Grillo found that officers with greater numbers of personal awards, those considered by the promotion board for the first time and those with a performance index in the highest ten percent were more likely to be selected for promotion to major.

#### **8. Study by Esmann**

In his 1984 NPS Thesis "Marine Officer Attrition Model," William Esmann attempted to develop an attrition prediction model that was more sophisticated and more accurate than reliance on historical average attrition rates. While he did not evaluate the effect of promotion potential on attrition, Esmann did hypothesize that officers with greater potential for promotion to higher ranks would be less likely to leave the Marine Corps since they assumed less risk remaining in a dead-end job. His research on the effects of unemployment on attrition is relevant to the retention of Marine officers and this thesis.

Basing his research on attrition data for the ranks of O-2 through O-5 during FY1977 through FY1983, Esmann used simple OLS regression models to analyze

impacts on attrition rates for each rank. He found that in every year the most significant predictor of attrition was the unemployment rate followed by military pay. Attrition rates were the highest when the unemployment rate and military pay were the lowest.

#### **9. Study by Theilmann**

In a 1990 NPS thesis "Analysis of the Factors Affecting Marine Corps Officer Retention," Robert Theilmann examined factors that affected retention of male, company-grade officers (O-1 through O-3) who had not yet completed their initial service obligation. He first used factor analysis to narrow the pool of variables that were drawn from the *1985 DOD Survey of Officer and Enlisted Personnel* and Defense Manpower Data Center and then used logistic regression techniques to analyze the binary outcome of whether or not an officer actually remained on active duty past his initial service obligation.

In his detailed analysis, Theilmann evaluated the effects of perceptions of the working environment and personal opportunities, demographic information, MOS and various time and tenure characteristics. He did not evaluate the effect of graduate education. He found that the factors that have the greatest impact on an officer's retention decision are commissioning source, marital status, MOS, race and various factors of job satisfaction. Officers from the Naval Academy and NROTC were more likely to remain than other sources. Married officers with children were more likely to remain than married officers without children and unmarried officers. Officers with support MOSs were less likely to remain on active duty. Minority officers were more likely to remain on active duty than Caucasian officers.

## **10. Study by Miller**

In his 1995 NPS Thesis "Impact of The Drawdown on Minority Officer Retention," Brian Miller attempted to analyze the differences between minority and non-minority officer retention as affected by the drawdown of the U.S. Military in the early 1990s. He used logistic regression models to individually analyze the differences in separation behavior for the 1977, 1980, 1983 and 1987 officer cohorts during each career phase.

Analysis of separation probability density functions allowed Miller to distinguish separate phases of an officer's career, each of which corresponds to different decision criteria for retention. The "attrition phase" lies between zero and four years in which an officer is usually bound by a service obligation. The "early-decision phase" lies between the fifth and eleventh year of service in which an officer is free to make his own decision to leave but is not yet committed to a long-term career. The "career phase" lies between the twelfth and twentieth year of service during which an officer has likely been promoted to O-4 and must accept the results of the O-5 selection board and either leave active duty or wait until retirement eligibility with full pension and benefits at 20 years.

While Miller found little convincing evidence of a difference in minority versus non-minority attrition, his results did reveal a significant trend regarding the possession of a graduate degree. For each cohort, officers with graduate degrees were less likely to separate during the early career phases and more likely to separate during the later career phases. This is not a surprising result given the obligated service of the "attrition phase," but it is also consistent throughout the "early decision phase" and "career phase."

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### **III. DATA**

#### **A. COLLECTION**

Data for this thesis were collected from several different sources. Promotion board data for the "in-zone" population of majors (O-4) considered by the FY1998 through FY2001 lieutenant colonel (O-5) promotion boards were collected from the Manpower Plans Division at Headquarters Marine Corps. This data consisted of social security number, whether or not an officer was selected for promotion and year of the board. "In-zone" refers to the status of being part of the primary promotion cohort considered for promotion for the first time. The Marine Corps does not generally promote officers from the "below-zone" (i.e, early) category to O-5.

Since an officer's date of commission is the basis for promotion from O-1 to O-2, it therefore affects subsequent promotions throughout an officer's career, as officers are identified by their year of commission. Data were collected for each accession cohort of Marine officers commissioned as second lieutenants (O-1) from 21 December 1979 through 28 September 1984. These dates correspond to the dates of commission for the senior officer from the FY1998 lieutenant colonel selection board and the junior officer considered by the FY2001 lieutenant colonel selection board.

The primary source for accession cohort data was the "Longitudinal TBS File," which was provided by the Center for Naval Analyses (CNA). This file consisted of personal characteristics at the time of commissioning, performance at The Basic School (TBS), highest educational attainment on record and separation data for all officers commissioned between the dates of interest (1979-1984) who remained on active duty

past November 1984. This file did not include officers who separated from active duty prior to November 1984.

Additional accession cohort data were collected from the Defense Manpower Data Center (DMDC) West, and the Manpower Information (MI), and Performance Evaluation divisions at Headquarters Marine Corps. This data consisted of characteristics relating to professional military education, personal awards, civilian educational attainment, prior enlisted service status, marital status as of last recorded observation, and number of dependents as of the last recorded observation. The performance evaluation data consisted of fitness report markings for all officers from the corresponding accession cohort for the ranks of O-1 through O-3.

Finally, data regarding graduate education were collected from the Registrar at the Naval Postgraduate School on all Marine officers who graduated from the Naval Postgraduate School between 1983 and 2000.

All data files were matched by social security number and date of commission and merged to create a single data file for analysis. Observations with missing critical data were removed from the sample, as were observations for officers commissioned without at least an undergraduate degree. Social security numbers were deleted from the data file to eliminate any privacy concerns. The only data that remained in the data set were those records that corresponded to the Longitudinal TBS File provided by CNA. Because of the limitations of the baseline CNA data set, 599 observations were deleted. Thus, the analysis file contains complete records for 6,507 officers commissioned as O-1s during the period 21 December 1979 through 28 September 1984. This sample of 6,507 officers will be referred to as the Accession Cohort Sample.

Sample selection issues based on the limitations of the CNA data set are not considered a serious weakness. The difference between the entire accession cohort population and the available sample is approximately 600 officers or 10 percent. An officer commissioned in early 1980 would have had to remain on active duty for a period of less than five years to be excluded from the sample. An officer commissioned in early 1982 would have had to remain on active duty for less than three years to be excluded from the sample. Most of these separations would have been due to medical or other special reasons. The data set accurately reflects officers commissioned later in the accession cohort who spent relatively short periods on active duty. Additionally, minimum service requirements (MSR) during the period that correspond to the accession cohort ranged from three years for the general ground assignable officer to six years for those officers with a guarantee of aviation training. Based on the available sample, the average time spent on active duty was approximately 8.8 years.

For the purpose of analyzing the probability of promotion to O-5, a second sample was drawn as a subset of the Accession Cohort Sample. This second sample consists only of the officers who survived on active duty long enough to be considered for promotion to O-5. This sample is called the Promotion Sample.

## **B. VARIABLE INTRODUCTION**

Model specification is based on Wise (1975), Wielsma (1996) and Bowman and Mehay (1999). Variables are grouped into the following categories: Outcomes, Cognitive Traits, Affective Traits, Performance Traits, Demographic Traits and Career Traits. Table I lists each variable from the Accession Cohort Sample and its description.

VARIABLE	DESCRIPTION
<b>Outcomes</b>	
SURVIVE	= 1 IF SURVIVED TO THE O-5 BOARD; = 0 OTHERWISE
SELECT	= 1 IF SELECTED FOR O-5; = 0 OTHERWISE
<b>Performance Traits</b>	
PINDEX	CONTINUOUS, = PERFORMANCE EVALUATION INDEX
GPA	CONTINUOUS, = TBS OVERALL GPA
AWARDS	CONTINUOUS, = NUMBER OF PERSONAL AWARDS
PME	= 1 IF COMPLETED INTERMED LEVEL SCHOOL; = 0 OTHERWISE
<b>Cognitive Traits</b>	
NPS	= 1 IF AN NPS GRADUATE; = 0 OTHERWISE
NOT NPS	= 1 IF OBTAINED A NON-NPS GRAD DEGREE; = 0 OTHERWISE
MASTERS	= 1 IF OBTAINED ANY MASTERS DEGREE; = 0 OTHERWISE
GCT	CONTINUOUS, = GCT SCORE
<b>Affective Traits</b>	
COMBAT	= 1 IF RECEIVED ONE COMBAT FITREP; = 0 OTHERWISE
PRIENL	= 1 IF 4 YEARS ACTIVE ENLISTED TIME; = 0 OTHERWISE
USNA	= 1 IF COMMISSION SOURCE IS USNA; = 0 OTHERWISE
NROTC	= 1 IF COMMISSION SOURCE IS NROTC; = 0 OTHERWISE
OTHER	= 1 IF NOT COMMISS. FROM NROTC OR USNA; = 0 OTHERWISE
CBTARMS	= 1 IF MOS IS COMBAT ARMS; = 0 OTHERWISE
SERVICE	= 1 IF MOS IS SERVICE SUPPORT; = 0 OTHERWISE
SUPPORT	= 1 IF MOS IS COMBAT SUPPORT; = 0 OTHERWISE
AVIATOR	= 1 IF AN AVIATOR; = 0 OTHERWISE
AVSPPT	= 1 IF MOS IS AVIATION SUPPORT; = 0 OTHERWISE
<b>Demographic Traits</b>	
COMM AGE	CONTINUOUS, = AGE AT FIRST COMMISSION
MARSTAT	= 1 IF EVER MARRIED; = 0 OTHERWISE
DEPEND	CONTINUOUS, = NUMBER OF DEPENDENTS
SEX	= 1 IF SEX IS MALE; = 0 OTHERWISE
WHITE	= 1 IF RACE IS WHITE; = 0 OTHERWISE
BLACK	= 1 IF RACE IS BLACK; = 0 OTHERWISE
O RACE	= 1 IF RACE IS NOT WHITE OR BLACK; = 0 OTHERWISE
<b>Career Traits</b>	
U RATE	CONTINUOUS, NATIONAL U-RATE AT FIRST CAREER DECISION
FY1998	= 1 IF IN-ZONE AT THE 1998 O-5 BOARD; = 0 OTHERWISE
FY1999	= 1 IF IN-ZONE AT THE 1999 O-5 BOARD; = 0 OTHERWISE
FY2000	= 1 IF IN-ZONE AT THE 2000 O-5 BOARD; = 0 OTHERWISE
FY2001	= 1 IF IN-ZONE AT THE 2001 O-5 BOARD; = 0 OTHERWISE

**Table I. Variable Name and Description, Grouped by Category.**

### **1. Outcomes**

The two major outcomes to be analyzed in this thesis are SURVIVE and SELECT. SURVIVE equals 1 if an officer remained on active duty long enough to be



considered by the O-5 promotion board. SELECT is a binary variable that equals 1 if an officer, considered by the O-5 selection board, was in fact selected for promotion.

## **2. Performance Traits**

Performance traits are indicators of actual performance at various points throughout an officer's career. PINDEX is a continuous variable for an officer's performance evaluation index. PINDEX was derived in a similar fashion to performance indexes constructed by Estridge (1995) and Wielsma (1996). The difference is that as described below, PINDEX weighted each individual fitness report based on the number of months of observation, whereas Estridge (1995) and Wielsma (1996) gave equal weight to each individual fitness report regardless of the number of months of observation.

In particular, PINDEX is based on marks from Section B of the Marine Corps' fitness report used prior to 1998, which consisted of 21 different evaluations of performance characteristics and leadership traits. A copy of this fitness report form is included in Appendix A. Based on the possible markings, PINDEX assigned a value of 0,1,3,5,7 and 9 for observations of Unsatisfactory, Below Average, Average, Above Average, Excellent and Outstanding, respectively. "Not Observed" fitness reports and "Not Observed" individual Section B markings were excluded from the calculation of PINDEX. For each officer, PINDEX calculated the weighted mean value for all observed Section B marks on each fitness report, summed the weighted means for all observed fitness reports received at the ranks of O-1 through O-3 and then divided by the total number of months of observation for all observed fitness reports combined.

PINDEX has a value that ranges from 0 to 9, with a mean of 8.566 and a standard deviation of .451.

Esmann (1984) hypothesized that an officer's potential for promotion to senior ranks was a critical factor in their decision to remain on active duty, and Wielsma(1996) found that officers with higher performance evaluation indexes were more likely to remain on active duty. Based on this, PINDEX is hypothesized to be positively related to an officer's retention to the O-5 promotion board, since officers with higher fitness report marks will have a greater expectation of continued success throughout their careers. Estridge (1995) found that, of all factors considered in his models for promotion to O-4 and O-5, his performance evaluation index had the greatest explanatory effect on promotion to both ranks. Since fitness reports are the primary source of information regarding actual on-the-job performance available to a promotion board, and since officers with the strongest fitness reports are the most likely to be promoted, PINDEX should be positively related to selection for promotion to O-5.

GPA is a continuous variable that reflects an officer's overall grade point average at The Basic School (TBS). This variable has a range of 74 to 100 and a mean of 86.78. GPA is based on an officer's performance in the first six months of their career when every Marine officer, regardless of MOS, receives the firm-specific training that will serve as a foundation for their entire Marine Corps career. An officer's GPA at TBS is a composite of scores from three evaluation categories: leadership, military skills and academics.

Wielsma (1996) found that officers with higher class standings at TBS were less likely to leave active duty prior to the promotion board for O-4 and more likely to be

promoted to O-4. In addition to measuring actual performance at TBS, GPA also serves as an indicator of ability and inclination for the military. Officers who excel early in training probably have a natural inclination toward the Marine Corps life and therefore are less likely to separate from the Marine Corps and more likely to be selected for promotion.

AWARDS is a continuous variable that measures the number of personal awards received by each officer considered by the O-5 selection board. This variable has a range of 0 to 18 and a mean of 4.69. Personal awards are awarded to individual officers who distinguish themselves in a given task or billet. Generally, awards are given for effort and performance that lie above the realm of expectation or routine. AWARDS provides the same weight to a Navy/Marine Corps Achievement Medal as it does to the Navy Cross or the Congressional Medal of Honor. A second or third issue of the same award is also given the same value as the first award. Estridge (1995) and Grillo (1996) both found that officers with greater numbers of personal awards were more likely to be promoted to the ranks of O-4 and O-5. Since personal awards are issued for performance considered a cut above the average, I expect that AWARDS will be positively related to promotion to O-5.

PME is a binary variable that equals 1 if an officer completed the appropriate-level professional military education (PME) to be considered for promotion to the following rank. For promotion to the rank of O-5, the appropriate-level PME is considered intermediate-level school, which includes either the resident or non-resident courses from the Marine Corps Command and Staff College, the Naval War College (Command and Staff), the Air Force Command and Staff College or the Army Command and General Staff College. Professional Military Education provides officers with the

requisite firm-specific education and training that will enable them to successfully fill a variety of billets appropriate for the next rank. Long (1992) found that officers who had completed their appropriate level PME were more likely to be promoted to the ranks of O-4 through O-6. In recent years, emphasis on completion of intermediate-level school for majors has increased to include indication of automatic exclusion from selection to O-5 if PME has not been completed. I expect the completion of intermediate-level PME will be positively related to promotion to O-5.

### **3. Cognitive Traits**

NPS is a binary variable that equals 1 if an officer received a graduate degree from the fully-funded program at the Naval Postgraduate School where his primary duty was to study a given field. One might expect that the quality of education received in a full-time graduate program to be greater than that of a part-time program. Thus, the officer with an NPS degree would be more productive than officers without graduate degrees or officers with graduate degrees obtained off-duty. From another perspective one might expect that an officer who attends NPS spends more time away from his "normal" career path, receives unobserved fitness reports while attending NPS, and might therefore be less likely to be promoted. Additionally, the specialized skills received at NPS and the subsequent "payback" tour might provide less utility to a Marine Corps that seeks versatile officers with a broad range of skills. As highlighted in studies by Cymrot (1986), Bowman and Mehay (1999) and Estridge (1995), studies of the effects of fully-funded graduate education, or NPS specifically on promotion have found a positive relationship. However, because of the unique nature of the Marine Corps culture and the discussion above, I make no hypothesis regarding the sign of the relationship between NPS and retention or promotion.

NOT\_NPS is a binary variable that equals 1 if an officer received a graduate degree from sources other than NPS. NOT\_NPS includes officers who received graduate degrees from intermediate level professional military education (PME) institutions such as Marine Corps CSC, Army CGSC, the Naval War College and the Air Command and Staff College. However, available data do not allow distinction between various graduate education sources other than NPS. While the data are not available to analyze the issue, the majority of officers with non-NPS graduate degrees earned them off-duty in part-time study via the Tuition Assistance Program.

Theoretically, officers with graduate degrees from sources other than NPS should be more productive than officers without graduate degrees. With the exception of officers with graduate degrees from PME institutions, officers with degrees from sources other than NPS might not be as productive as officers with NPS degrees since their effort toward educational achievement had substantial competition from normal military duties. Moreover, off-duty students are not required to study military-specific subjects. On the other hand, graduate degrees from PME institutions provide firm-specific education, which the Marine Corps may value more than broad-based general education. While the studies highlighted in Chapter II either evaluated the effects of graduate degrees from any source or the effects of fully-funded graduate degrees only, they did not specifically study the effects of non-NPS graduate degrees. Based on the mixed perceptions highlighted in Chapter I, I make no hypothesis on the direction of relationships between NOT\_NPS and retention or promotion to O-5.

MASTERS is a binary variable that equals 1 if an officer received a graduate degree from any source. If NPS or NOT\_NPS equals 1, then MASTERS equals 1. In

theory, officers with any graduate degree should be more productive than officers without graduate degrees. Bowman and Mehay (1999) found that even after controlling for the effects of selection bias, graduate education had a positive impact on the promotion of Navy officers to O-4. Wielsma (1996) found that Marine officers with graduate degrees were more likely to remain on active duty until the O-4 promotion board, but less likely to be promoted to O-4 after controlling for sample selection and self-selection bias. Other studies that analyzed the effects of graduate education on promotion of Marine officers yielded mixed results. Based on these prior studies and discussion from Chapter I, I make no hypothesis regarding the effects of graduate education on retention and promotion of Marine officers.

GCT reflects an officer's score on the General Classification Test. The GCT is similar to the Scholastic Aptitude Test (SAT) in that it tests mathematical ability and reading ability. According to North and Smith (1993), scores on the two tests are highly correlated. The GCT also tests an officer's mechanical aptitude. The GCT is traditionally used by the military as a measure of mental aptitude upon entrance. Scores can range from 0 to 160, with 160 being the highest possible score. The mean GCT score from the Accession Cohort Sample is 129.59.

While North and Smith (1993) found that GCT was not a statistically significant factor in explaining promotion to O-3 or O-4, Wielsma (1996) and Estridge (1995) found that officers with higher GCT scores were less likely to be promoted to O-4 and O-5, although the difference was not significant. Wielsma (1996) also found that officers with higher GCT scores were less likely to hold graduate degrees while holding all else constant. Estridge (1995) concluded that GCT was a poor indicator of cognitive ability.

For lack of alternative measures of cognitive ability, I use GCT score to explain variance in selection for graduate education and promotion to O-5. I hypothesize that officers with higher GCT scores are more likely to self-select for graduate education and more likely to be promoted since they possess greater cognitive abilities.

#### **4. Affective Traits**

COMBAT is a binary variable that equals 1 if an officer received at least one combat fitness report. Combat fitness reports, as opposed to normal fitness reports, are written on officers who have served under combat conditions and theoretically faced greater conditions of personal stress and physical demand. Officers who prove themselves under combat conditions leave little doubt about their true value to a warfighting organization like the Marine Corps.

Wielsma (1996) found that, although officers with combat experience were more likely to be promoted to O-4, the relationship was not statistically significant. Since combat experience provides the ultimate in firm-specific training for the Marine Corps, and since officers with combat experience are traditionally revered by those without it, I expect that COMBAT will be positively related to promotion to O-5.

PRIENL is a binary variable that equals 1 if an officer spent at least four years on active duty as an enlisted person.<sup>1</sup> Officers with previous enlisted experience are referred to as "mustang" officers in the Marine Corps and traditionally respected for their experience and understanding of the enlisted perspective. Additionally, prior enlisted

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<sup>1</sup> The variable PRIENL is based on the rank designator at time of commission and is the most concrete measure of enlisted service available for analysis. Officers commissioned as O1Es served at least 4 years on active duty in enlisted status.

officers generally have at least four more years of firm-specific training in the military establishment than those who joined the Marine Corps as officers.

Wielsma (1996) found that prior enlisted officers were less likely to be promoted to O-4 but more likely to remain on active duty until the O-4 board. Prior enlisted officers may choose to remain on active duty until the O-4 point since this milestone could bring them closer to the 20 year retirement mark; however, an officer with 4 years of active enlisted service prior to commission may be less likely to remain until the O-5 promotion board since they would have met the 20 year mark prior to the board convening and could retire with full pension and benefits as an O-4. Because of their additional firm-specific capital and obvious taste for the military, I expect that prior enlisted officers who remain to the O-5 board are more likely to be promoted to O-5 than officers with direct commissions.

The variables USNA, NROTC and OTHER are all binary variables that reflect an officer's source of commission. Officers commissioned from the U.S. Naval Academy began receiving firm-specific training and education four years prior to their commission. They also survived a rigorous mental, physical and moral screening process throughout their time at the Academy as well as during their initial screening for entrance into the Academy. Officers commissioned through the NROTC program also received a greater level of firm-specific training during college than did those commissioned from other sources. Officers commissioned through the USNA or NROTC program demonstrated a personal taste for the military as they were more likely to seek out military commissioning programs as opposed to being recruited. OTHER refers to officers commissioned through the MECEP Program, the Enlisted Commissioning Program



(ECP) the Platoon Leaders Course (PLC) and Officer Candidates Class (OCC). These officers attended normal civilian colleges at their own expense and received no formal military training during their undergraduate schooling with the exception of attending Officer Candidates School during the summer. Entrance into these programs is not as academically competitive as the entrance into the USNA or NROTC Scholarship Programs.

Studies highlighted in Chapter II provide mixed results regarding the effects of USNA, NROTC and OTHER commissioning sources on graduate school completion, retention and promotion. Studies by Bowman and Mehay (1999) and Wielsma (1996) are consistent in finding that officers from the USNA seem more likely to hold graduate degrees than officers from NROTC or other sources. North and Smith (1993), and Wielsma (1996) both find that officers from the NROTC Program are more likely to remain on active duty until consideration for promotion to O-4 than officers from the USNA or officers from other sources, but Theilmann (1990) and North and Smith (1993) both found that USNA graduates were more likely than NROTC officers to remain on active duty until consideration for promotion to O-3. This finding could be due to the five-year service obligation for USNA graduates. North and Smith (1993) and Estridge (1995) both found that USNA graduates were more likely to be promoted to the rank of O-4 than officers from other sources, while Wielsma (1996) found that officers from the USNA and NROTC program were less likely to be promoted to O-4.

Occupational specialties are categorized by the binary variables CBTARMS, SERVICE, SUPPORT, AVIATOR and AVSPPT to reflect the differences across each skill group. Table II identifies the MOSs in each occupational category.

Officers from different occupational fields face different opportunities within the Marine Corps as well as in the civilian labor market and can be expected to behave differently. Officers in the CBTARMS and AVIATOR categories constitute the largest numbers of general officers and command the warfighting units in the Marine Corps. However, the firm-specific training acquired by the combat arms officer has little direct value in the civilian market, whereas the general training received by the aviators has substantial demand in the civilian market.

<b>VARIABLE</b>	<b>Military Occupational Specialty</b>
<b>COMBAT</b>	INFANTRY (03XX)
	FIELD ARTILLERY (18XX)
	TANKS AND ASSUALT AMPHIBIOUS (18XX)
<b>SERVICE</b>	PERSONNEL AND ADMINISTRATION (01XX)
	FINANCE AND ACCOUNTING (34XX)
	DATA SYSTEMS (40XX)
	MARINE CORPS EXCHANGE (41XX)
	PUBLIC AFFAIRS (43XX)
	LEGAL SERVICES (44XX)
	TRAINING AND AUDIOVISUAL (46XX)
<b>SUPPORT</b>	INTELLIGENCE (02XX)
	LOGISTICS (04XX)
	COMMUNICATIONS (06XX)
	SIGNALS INTELLIGENCE (26XX)
	SUPPLY (30XX)
	MOTOR TRANSPORT (35XX)
<b>AVVSPPT</b>	ELECTRONICS MAINTENANCE (59XX)
	AIRCRAFT MAINTENANCE (60XX)
	ANTI-AIR WARFARE (72XX)
<b>AVIATOR</b>	ALL PILOTS AND NAVAL FLIGHT OFFICERS (75XX)

**Table II. Occupational Category Variables and Associated Military Occupational Specialty (MOS).**

Officers from the SERVICE category provide general service functions to all supporting and operational elements of the Marine Corps and possibly enjoy the least glamour. However, officers from the SERVICE category receive general training that is valuable in the private sector. Officers from the SUPPORT and AVSPPT MOSs receive a

relatively balanced mix of general and firm-specific training in their support role for the operational elements of the Marine Corps. The two categories are distinguished by AVSPPT officers' specific value to the aviation industry in the private sector. In addition to different types and mixes of training, officers from different MOS categories may have different tastes and aspirations that led them to choose their occupational fields when they entered the Marine Corps.

While few of the prior studies of retention and promotion of Marine Officers yielded statistically significant relationships based on occupational category, both North and Smith (1993) and Wielsma (1996) found that aviators were more likely to be promoted to the rank of O-4 than officers from other occupational categories.

## **5. Demographic Traits**

Every study highlighted in Chapter II used a combination of demographic variables to explain variation in either promotion rates or retention. The sociological norms of the military and the U.S. in general, as well as the structural differences in professional opportunities within military all impact the behavior of individuals of different age, sex, marital status, dependent status and race.

COMM\_AGE is a continuous variable that reflects an officer's age at the time of commission. Officers who are older at the time of commission are perhaps more mature and therefore more productive than younger officers, but younger officers may have a stronger taste for the military as indicated by entering the military at an earlier age.

MARSTAT is a binary variable that equals 1 if an officer had ever been married as of the last or most recent entry in their official file. DEPEND is a continuous variable that reflects the number of dependents each officer had, not including the spouse, as of

the last or most recent entry in their official file. Research in the field of labor economics consistently finds that married people and those with dependents are more productive than those who are not married and those without dependents. Married officers and officers with dependents may be more likely to remain on active duty because of the job security associated with the military. They may be more likely to be promoted than unmarried officers and officers without dependents since they have already committed themselves to the Marine Corps as their only alternative and the livelihood of their family is at stake. Thus, their motivation to perform well is perhaps greater than single officers.

Bowman and Mehay (1999) and North and Smith (1993) found that married officers were more likely to be promoted to the ranks of O-4 in the Navy and Marine Corps, respectively, than officers who were not married. Wielsma (1996) found that after controlling for self-selection for graduate education and the retention decision, officers who had never been married were more likely to be promoted to O-4 than officers who were or who had been married. North and Smith (1993) and Wielsma (1996) found that married officers were more likely to remain on active duty until the O-4 selection board.

The variables WHITE, BLACK and O\_RACE are all binary variables that reflect an officer's race. The variable O\_RACE reflects any race other than White or Black. Race variables are generally included in economic studies to identify whether race based differences in promotion or performance exist. Since the early 1990s, the U.S. military has been under increasing pressure to explain variation in retention and promotion rates of the different races. While all of the prior studies highlighted in Chapter II included race variables, only North and Smith (1993) found that minority status had a significant impact on promotion to O-3, and Thielmann (1990) found that minority officers were

more likely to remain on active duty at the rank of O-3 than non-minorities. No other study provided convincing evidence of systematic difference in retention or promotion rates based on race.

## **6. Career Traits**

Career traits address timing of various events during an officer's career. U\_RATE is a continuous variable that reflects the national unemployment rate of adults over the age of 16 in managerial and professional specialty occupations in the year in which an officer completed his initial service obligation. U\_RATE represents the national unemployment rate at an officer's first career stay-leave decision and is based on the following contract lengths: 5 years for USNA, 4 years for NROTC, 3 years of all other accession sources and 6 years for aviators from any accession source. U\_RATE has a range of 1.8 to 3.1 percent and a mean of 2.32 percent. Wielsma (1996) and Esmann (1984) found both found that officers were more likely to separate from active duty in years with lower national unemployment rates.

The variables FY1998, FY1999, FY2000 and FY2001 are all binary variables that reflect which particular year an officer was considered in the primary zone for promotion to O-5. Because the Marine Corps promotes to fill vacancies, promotion opportunities vary due to availability of vacancies in the higher grades. Individual promotion boards also have different precepts that must be held constant in order to isolate the effects of the other explanatory variables.

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## IV. PRELIMINARY DATA ANALYSIS

### A. THE ACCESSION COHORT SAMPLE

Before developing multivariate models to estimate the effects of graduate education on retention and promotion of Marine officers, we must first draw insight from the descriptive statistics of the Accession Cohort Sample.

Table III provides number of observations and frequency for categorical variables, and the mean (or percentage), and standard deviation for all of the analysis variables. The cohort contains 6,507 initial members. The variable SURVIVE has a mean value of .25. For binary variables such as SURVIVE, the mean value indicates the percentage of total observations for which the variable has a value of 1. Hence, only 25 percent of the officers in the Accession Cohort Sample survived on active duty long enough to be considered for promotion to O-5. Note that the O-5 promotion board occurs at roughly 16 years of service. Of the 1,627 officers who survived to the O-5 board, 68.2 percent were actually selected. The mean PINDEX of 8.56 on a range of 0 to 9 indicates a highly inflated performance evaluation system. Regarding graduate education, 19.5 percent of the officers received graduate degrees from any source at some time; 4.7 percent received their degrees from NPS while 14.8 percent received graduate degrees from sources other than NPS.

Nearly 75 percent of the officers in the Accession Cohort Sample were commissioned through programs other than the Naval Academy or NROTC. Approximately 75 percent of the officers were married at some point in their careers. Over 96 percent of the officers were male and over 93 percent were of the white race.

Table IV compares the mean values for each independent variable of the Accession Cohort Sample for two groups: those officers who stayed on active duty long enough to be considered for promotion to O-5 and those who left prior to the O-5 promotion point. Of those who did not stay, only those with prior enlisted experience (6 percent) would have been eligible to retire. The t-statistic tests whether the mean of each variable differs between the two groups.

For example, officers who stayed to the O-5 promotion board had a mean performance evaluation index (PINDEX) of 8.84, whereas officers who did not stay had a mean performance evaluation index of 8.47. This difference, although small, is statistically significant because the standard deviation in Table III indicates the variation around the mean is small.

Of officers who survived to the O-5 promotion point, 52.7 percent had a master's degree (MASTERS) from any source; conversely, only 8.4 percent of officers who did not survive had a master's degree. Note this suggests that getting a master's does not lead to an officer leaving the Marine Corps (to the extent cause and effect run in this direction). Based on the significant differences in Table IV, one can make the following characterizations of officers who stayed until the O-5 board compared to officers who did not survive:

- Survivors had higher performance indexes
- Survivors were more likely to hold a graduate degree from any source
- Survivors had higher GPAs at TBS
- Survivors were more likely to have previous enlisted active duty service.
- Survivors were more likely to have combat experience
- Survivors were more likely to be married
- Survivors had a greater number of dependents



Variable	N	Frequency	Mean or Percent	Std Dev
SURVIVE	6507	1627	0.2500384	0.4330682
SELECT	1627	1110	0.6822372	0.4655087
PINDEX	6507	-----	8.5664845	0.4512333
GPA	6507	-----	86.7863839	3.6548162
MAJOR	6507	2192	0.336868	0.4726757
NPS	6507	306	0.0470263	0.2117114
NOT NPS	6507	965	0.1483018	0.3554262
MASTERS	6507	1271	0.1953281	0.3964835
GCT	6507	-----	129.5935147	10.398617
COMBAT	6507	1362	0.209313	0.4068495
PRIENL	6507	407	0.062548	0.2421668
USNA	6507	702	0.1078838	0.3102575
NROTC	6507	1104	0.1696634	0.3753657
OTHER	6507	4701	0.7224527	0.4478232
CBTARMS	6507	1715	0.2635623	0.4405985
SERVICE	6507	542	0.0832949	0.2763487
SUPPORT	6507	1718	0.2640234	0.4408457
AVIATOR	6507	2088	0.3208852	0.4668526
AVSPPT	6507	443	0.0680805	0.2519034
COMM AGE	6507	-----	22.9403719	1.8080695
MARSTAT	6507	4863	0.747349	0.4345659
DEPEND	6507	-----	1.8161979	1.6203712
SEX	6507	6251	0.9606578	0.1944228
WHITE	6507	6109	0.9388351	0.239651
BLACK	6507	287	0.0441063	0.2053472
O RACE	6507	111	0.0170586	0.1294996
U RATE	6507	-----	2.4592132	0.3630098

**Table III. Descriptive Statistics for the Accession Cohort Sample.**

Table V compares mean values of each independent variable of the Accession Cohort Sample for two groups: officers who had graduate degrees from any source (MASTERS) and those with no graduate degree at all. Officers with graduate degrees survived at a 68 percent rate versus only a 14.6 percent survival rate for those without graduate degrees. Officers with graduate degrees had higher performance evaluation indexes, higher GPAs at TBS and higher GCT scores compared to officers without degrees. Graduate degree holders are more often commissioned via the USNA or

NROTC. In fact, the two groups differ with respect to all variables in Table V except O\_RACE.

VARIABLE	SURVIVED TO O-5 BOARD		
	NO (N=4880)	YES (N=1627)	T STAT
PINDEX	8.4731	8.8467	-50.22**
NPS	0.0199	0.1285	-12.72**
NOT NPS	0.0648	0.3989	-26.43**
MASTERS	0.0846	0.5274	-34.04**
GPA	86.332	88.151	-18.19**
GCT	129.51	129.84	-1.13
COMBAT	0.1547	0.3731	-16.72**
PRIENL	0.0582	0.0756	-2.36*
USNA	0.1049	0.1168	-1.3
NROTC	0.1643	0.1856	-1.93
OTHER	0.7307	0.6976	2.54*
CBTARMS	0.2697	0.2452	1.97*
SERVICE	0.0861	0.075	1.45
SUPPORT	0.2633	0.2661	-0.22
AVIATOR	0.3156	0.3368	-1.58
AVSPPT	0.0652	0.0768	-1.62
COMM AGE	22.933	22.964	-0.6
MARSTAT	0.6752	0.9637	-24.21**
DEPEND	1.4492	2.917	-35.36**
SEX	0.9582	0.968	-1.89
WHITE	0.9338	0.9539	-3.19**
BLACK	0.0482	0.032	3.04**
O_RACE	0.018	0.0141	1.12
** Statistically significant at the .01 level			
* Statistically significant at the .05 level			

**Table IV. Mean Value of Independent Variables of the Accession Cohort Sample by SURVIVE.**

Table VI (columns 1-3) compares mean values for each variable for two groups: officers with graduate degrees from NPS and those without any graduate degree. Officers with graduate degrees from NPS survived at a 68 percent rate versus a 14.7 percent survival rate for those without graduate degrees. Officers with NPS degrees had higher

performance evaluation indexes, higher GPAs at TBS and higher GCT scores. Those who attend NPS were more likely to be commissioned via the USNA or NROTC.

Variable	GRADUATE DEGREE FROM ANY SOURCE		
	NO (N=5236)	YES (N=1271)	T STAT
SURVIVE	0.1469	0.6751**	-37.67**
PINDEX	8.5097	8.8004**	-31.94**
GPA	86.443	88.202**	-15.57**
GCT	129.12	131.55**	-7.36**
COMBAT	0.1887	0.2943**	-7.6**
PRIENL	0.0512	0.1094**	-6.27**
USNA	0.0978	0.1495**	-4.78**
NROTC	0.1631	0.1967**	-2.74**
OTHER	0.7391	0.6538**	5.82**
CBTARMS	0.2689	0.2415*	2.03*
SERVICE	0.067	0.1503**	-7.85**
SUPPORT	0.2574	0.2911*	-2.39*
AVIATOR	0.343	0.2297**	8.39**
AVSPPT	0.0634	0.0873**	-2.78**
COMM AGE	22.882	23.183**	-4.73**
MARSTAT	0.7024	0.9323**	-24.29**
DEPEND	1.5982	2.7144**	-22.78**
SEX	0.965	0.9426**	3.21**
WHITE	0.9351	0.9544**	-2.85**
BLACK	0.0466	0.0338*	2.18*
O RACE	0.0183	0.0118	1.84
** Statistically significant at the .01 level			
* Statistically significant at the .05 level			

**Table V. Mean Values of Independent Variables of the Accession Cohort Sample by MASTERS.**

Table VI also compares mean values for officers with graduate degrees from sources other than NPS with officers without graduate degrees (columns 4-6). Officers with degrees from sources other than NPS survived at a higher rate than those with no graduate degree at all. Those with degrees from sources other than NPS had higher mean scores on the same measured performance traits – PINDEX, GPA and GCT.

VARIABLE	GRADUATE DEGREE FROM NPS			GRADUATE DEGREE NOT FROM NPS (NOT_NPS)		
	NO (N=5236)	YES (N=306)	T STAT	NO (N=5236)	YES (N=965)	T STAT
SURVIVE	0.1469	0.683	-25.25**	0.1469	0.6725	-33.09**
PIINDEX	8.5097	8.8541	-37.63**	8.5097	8.7834	-26.47**
GPA	86.443	88.918	-12.85**	86.443	87.975	-11.87**
GCT	129.12	135.41	-10.19**	129.12	130.32	-3.32**
COMBAT	0.1887	0.1863	0.11	0.1887	0.3285	-8.70**
PRIENL	0.0512	0.1569	-5.02**	0.0512	0.0943	-4.36**
USNA	0.0978	0.2614	-6.42**	0.0978	0.114	-1.47
NROTC	0.1631	0.2059	-1.80	0.1631	0.1938	-2.24*
OTHER	0.7391	0.5327	7.07**	0.7391	0.6922	2.92**
CBTARMS	0.2689	0.1993	2.94**	0.2689	0.2549	0.91
SERVICE	0.067	0.1536	-4.14**	0.067	0.1492	-6.86**
SUPPORT	0.2574	0.3693	-3.95**	0.2574	0.2663	-0.57
AVIATOR	0.343	0.1601	8.31**	0.343	0.2518	5.91**
AVSPPT	0.0634	0.1176	-2.89**	0.0634	0.0777	-1.55
COMM AGE	22.882	23.013	-1.12	22.882	23.236	-4.89**
MARSTAT	0.7024	0.9771	-25.82**	0.7024	0.9181	-19.86**
DEPEND	1.5982	3.0784	-15.84**	1.5982	2.599	-18.46**
SEX	0.965	0.9641	0.09	0.965	0.9358	3.53
WHITE	0.9351	0.951	-1.24	0.9351	0.9554	-2.73**
BLACK	0.0466	0.0294	1.70	0.0466	0.0352	1.72
O RACE	0.0183	0.0196	-0.16	0.0183	0.0093	2.50*
** Statistically significant at the .01 level						
* Statistically Significant at the .05 level						

**Table VI. Mean Values of Independent Variables of the Accession Cohort Sample by NPS and by NOT\_NPS.**

## **B. THE PROMOTION SAMPLE**

Table VII provides descriptive statistics for officers from the Promotion Sample. Of the 1,627 officers who stayed in the Marine Corps and were considered for promotion to O-5, 68.2 percent were selected, 52.7 percent had graduate degrees from any source, 12.8 percent had graduate degrees from NPS and 39.8 percent had graduate degrees from sources other than NPS.

Variable	N	Mean	Std Dev
SELECT	1627	0.6822372	0.4657498
PINDEX	1627	8.8467039	0.1121409
GPA	1627	88.1505839	3.4552229
AWARDS	1627	4.6982176	2.4695968
PME	1627	0.6127843	0.4872634
NPS	1627	0.1284573	0.3347012
NOT NPS	1627	0.3988937	0.4898214
MASTERS	1627	0.527351	0.4994049
GCT	1627	129.8389674	10.0199005
COMBAT	1627	0.3730793	0.4837716
PRIENL	1627	0.0755993	0.2644371
USNA	1627	0.1167793	0.3212559
NROTC	1627	0.1856177	0.3889174
OTHER	1627	0.697603	0.4594375
CBTARMS	1627	0.2452366	0.4303597
SERVICE	1627	0.0749846	0.2634475
SUPPORT	1627	0.266134	0.442071
AVIATOR	1627	0.3368162	0.4727668
AVSPPT	1627	0.0768285	0.266401
COMM AGE	1627	22.9637369	1.8592643
MARSTAT	1627	0.9637369	0.1870015
DEPEND	1627	2.9170252	1.4293098
SEX	1627	0.9680393	0.1759494
BLACK	1627	0.0319607	0.1759494
O RACE	1627	0.0141364	0.1180897
FY1998	1627	0.2421635	0.4285244
FY1999	1627	0.2083589	0.4062597
FY2000	1627	0.3171481	0.4655087
FY2001	1627	0.2323294	0.4224478

**Table VII. Descriptive Statistics for the Promotion Sample.**

Table VIII compares mean values of each independent variable of the Promotion Sample for two groups: officers who were selected for promotion to O-5 and those who were not selected. The following characterizations can be drawn regarding officers who were selected for promotion to O-5 compared to those where were not selected:

- Selectees had a higher early performance evaluation index
- Selectees had a higher GPA at TBS

- Selectees had a greater number of personal awards
- Selectees were more likely to have completed intermediate-level PME
- Selectees were equally likely to have an NPS degree
- Selectees were more likely to hold graduate degrees from sources other than NPS
- Selectees were more likely to hold graduate degrees from any source

Table IX compares mean values of each independent variable of the Promotion Sample for two groups: officers who hold graduate degrees from any source and those who do not hold a graduate degree at all. Officers who hold a graduate degree were selected for O-5 at a 77.4 percent rate, versus a 58.0 percent promotion rate for those without a graduate degree. Officers with graduate degrees had superior means on all performance traits including completion of PME.

Table X (Columns 1-3) compares mean values of each variable of the Promotion Sample for two groups: officers who hold graduate degrees from NPS and those without a graduate degree at all. Officers with NPS degrees were selected for promotion at rate of 67.9 percent versus a 58.0 percent selection rate for those without graduate degrees. Officers who had NPS degrees had higher performance evaluation indexes and GPAs at TBS, although they had fewer personal awards and were less likely to have completed their PME.

Table X (columns 4-6) also compares mean values of each variable for officers with graduate degrees from sources other than NPS and those with no graduate degree at all. Officers with non-NPS graduate degrees were selected for promotion to O-5 at a rate of 80.4 percent versus a rate the 58 percent for officers without a graduate degree at all. Officers with non-NPS graduate degrees had higher performance evaluation indexes,

higher GPAs at TBS, had more personal awards and were more likely to have completed their PME compared to those with no degree.

Variable	Selected for Promotion to O-5		
	NO (N=517)	YES (N=1110)	T STAT
PINDEX	8.8077	8.8649	-9.3**
GPA	87.509	88.45	-5.07**
AWARDS	4.0193	5.0144	-8.21**
PME	0.3907	0.7162	-12.82**
NPS	0.1296	0.1279	0.09
NOT NPS	0.2456	0.4703	-9.3**
MASTERS	0.3752	0.5982	-8.61**
GCT	129.45	130.02	-1.11
COMBAT	0.352	0.3829	-1.21
PRIENL	0.0948	0.0667	1.89
USNA	0.1044	0.1225	-1.08
NROTC	0.1915	0.1829	0.41
OTHER	0.7041	0.6946	0.39
CBTARMS	0.2553	0.2405	0.64
SERVICE	0.0832	0.0712	0.83
SUPPORT	0.3211	0.2405	3.32**
AVIATOR	0.2863	0.3604	-3.02**
AVSPPT	0.0542	0.0874	-2.54*
COMM AGE	23.217	22.846	3.68
MARSTAT	0.9574	0.9667	-0.89
DEPEND	2.8917	2.9288	-0.48
SEX	0.9787	0.9631	1.84
WHITE	0.942	0.9595	-1.47
BLACK	0.0406	0.0279	1.27
O RACE	0.0174	0.0126	0.72
FY1998	0.236	0.245	-0.4
FY1999	0.2012	0.2117	-0.49
FY2000	0.3075	0.3216	-0.57
FY2001	0.2553	0.2216	1.47
** Statistically Significant at the .01 level			
* Statistically Significant at the .05 level			

**Table VIII. Mean Values of Independent Variables of the Promotion Sample by SELECT.**

Variable	GRADUATE DEGREE FROM ANY SOURCE (MASTERS)		
	NO (N=769)	YES (N=858)	T STAT
SELECT	0.58	0.7739	-8.49**
PINDEX	8.8329	8.8591	-4.74**
GPA	87.701	88.554	-5.00**
AWARDS	4.4889	4.8858	-3.26**
PME	0.5046	0.7098	-8.63**
NPS	0	0.2436	-16.61**
NOT NPS	0	0.7564	-51.59**
GCT	128.67	130.89	-4.51**
COMBAT	0.3992	0.3497	2.06*
PRIENL	0.0689	0.0816	-0.97
USNA	0.091	0.1399	-3.1**
NROTC	0.1691	0.2005	-1.63
OTHER	0.7399	0.6597	3.54
CBTARMS	0.2315	0.2576	-1.22
SERVICE	0.0572	0.0909	-2.61**
SUPPORT	0.2406	0.289	-2.22*
AVIATOR	0.407	0.2739	5.7**
AVSPPT	0.0637	0.0886	-1.9
COMM AGE	22.979	22.95	0.32
MARSTAT	0.9532	0.9732	-2.13*
DEPEND	2.9233	2.9114	0.17
SEX	0.974	0.9627	1.3
WHITE	0.9441	0.9627	-1.77
BLACK	0.0377	0.0268	1.24
O RACE	0.0182	0.0105	1.3
** Statistically Significant at the .01 level			
* Statistically Significant at the .05 level			

**Table IX. Mean Values of Independent Variables of the Promotion Sample by MASTERS.**



Variable	Graduate Degree From NPS			Graduate Degree Not From NPS (NOT NPS)		
	NO (N=769)	YES (N=209)	T STAT	NO (N=769)	YES (N=649)	T STAT
SELECT	0.58	0.6794	-2.69**	0.58	0.8043	-9.56**
PINDEX	8.8329	8.8682	-4.44**	8.8329	8.8561	-3.38**
GPA	87.701	88.722	-4.05**	87.701	88.499	-4.32**
AWARDS	4.4889	4.1292	2.19*	4.4889	5.1294	-4.76**
PME	0.5046	0.4833	0.55	0.5046	0.7827	-11.47**
GCT	128.67	134.06	-6.74**	128.67	129.87	-2.28*
COMBAT	0.3992	0.2153	5.48**	0.3992	0.3929	0.24
PRIENL	0.0689	0.0957	-1.20	0.0689	0.077	-0.58
USNA	0.091	0.2584	-5.22**	0.091	0.1017	-0.68
NROTC	0.1691	0.2249	-1.75	0.1691	0.1926	-1.15
OTHER	0.7399	0.5167	5.86**	0.7399	0.7057	1.43
CBTARMS	0.2315	0.1962	1.12	0.2315	0.2773	-1.97*
SERVICE	0.0572	0.1292	-2.91**	0.0572	0.0786	-1.58
SUPPORT	0.2406	0.3732	-3.59**	0.2406	0.2619	-0.92
AVIATOR	0.407	0.1866	6.82**	0.407	0.302	4.15**
AVSPPT	0.0637	0.1148	-2.15*	0.0637	0.0801	-1.19
COMM AGE	22.979	22.775	1.45	22.979	23.006	-0.27
MARSTAT	0.9532	0.9761	-1.75	0.9532	0.9723	-1.91
DEPEND	2.9233	3.0144	-0.79	2.9233	2.8783	0.60
SEX	0.974	0.9665	0.55	0.974	0.9615	1.32
WHITE	0.9441	0.9569	-0.79	0.9441	0.9646	-1.86
BLACK	0.0377	0.0287	0.67	0.0377	0.0262	1.24
O RACE	0.0182	0.0144	0.40	0.0182	0.0092	1.47
** Statistically Significant at the .01 level						
* Statistically Significant at the .05 level						

**Table X. Mean Values of Independent Variables of the Promotion Sample by NPS and NOT\_NPS.**

### C. SUMMARY

Preliminary analysis of the descriptive statistics provided in this Chapter gives some indication that the expected relationships regarding the effects of graduate education on retention and promotion of Marine officers will be supported in the multivariate models. Officers with graduate degrees from any source were more likely to survive to the O-5 promotion board and more likely to be promoted than officers without graduate degrees. Officers with NPS degrees were more likely to survive and be

promoted to O-5 than officers without graduate degrees. Officers with graduate degrees from sources other than NPS were more likely to survive and be promoted than officers with no graduate degree at all. Based on this preliminary analysis, no inferences can be drawn from direct comparisons between officers with NPS degrees and those with graduate degrees from other sources.

## **V. MULTIVARIATE ANALYSIS**

Multivariate modeling allows for the isolation of the effects of a given explanatory variable while holding the effects of other explanatory variables constant. The most common method of multivariate analysis is ordinary least squares (OLS), which is most often used to explain variance of a continuous explanatory variable. The use of OLS to estimate models with a binary (0,1) dependent variable is referred to as a linear probability model (LPM). This model is inherently flawed as it uses a linear functional form to explain a non-linear function. This thesis will use the probit model for a binary outcome that uses a continuous probability distribution to predict the probability that a binary dependent variable has a value of 1. Since this thesis analyzes the binary outcomes of retention to the O-5 promotion point (SURVIVE) and selection for promotion to O-5 (SELECT), the probit model is appropriate. (North and Smith 1993)

### **A. MODELING FOR RETENTION**

Initial analysis of the Accession Cohort Sample uses a simple probit model to estimate the effects of graduate education on the retention of Marine Officers to the O-5 promotion point. Table XI provides the results of these initial models. The binary dependent variable SURVIVE reflects whether or not an officer in an initial entry cohort remained on active duty until the O-5 promotion point (roughly 16 years). Model 1 includes MASTERS as the graduate education variable and Model 2 distinguishes between graduate degrees from NPS and those received from sources other than NPS (NOT\_NPS).

These models reflect OTHER as the omitted accession source and CBTARMS as the omitted MOS category. Model 1 compares MASTERS to no graduate degree at all and Model 2 compares both NPS and NOT\_NPS to no graduate degree at all.

The log-likelihood ratio test provides one measure of goodness of fit for models with binary dependent variables. It tests the null hypothesis that the set of explanatory variables does not explain any of the variation in the dependent variable. In the case of Models 1 and 2 the null hypothesis is rejected. Thus, the set of explanatory variables does provide some explanatory power. Another measure of goodness of fit is an assessment of

	Model 1		Model 2	
	Coeff.	Std.Err.	Coeff.	Std.Err.
INTERCEPT	-36.3731**	1.5592	-36.5129**	1.5627
PINDEX	3.9138**	0.1705	3.9263**	0.1708
GPA	0.0023	0.0068	0.0028	0.0068
MASTERS	1.0531** [.1203]	0.0514	-----	-----
NPS	-----	-----	0.9289** [.1057]	0.0864
NOT_NPS	-----	-----	1.0948** [.1245]	0.0567
COMBAT	0.5102**	0.0498	0.5047**	0.0500
PRIENL	-0.3667**	0.0966	-0.3571**	0.0968
USNA	-0.1866*	0.0758	-0.1735*	0.0760
NROTC	-0.0007	0.0648	0.0008	0.0648
SERVICE	-0.2179*	0.0927	-0.2151*	0.0927
SUPPORT	0.1281*	0.0651	0.1347*	0.0652
AVIATOR	0.2110**	0.0677	0.2088**	0.0678
AVSPPT	0.0527	0.0985	0.0600	0.0986
COMM AGE	-0.0156	0.0147	-0.0166	0.0147
MARSTAT	0.5782**	0.0895	0.5787**	0.0895
DEPEND	0.1739**	0.0160	0.1752**	0.0160
SEX	-0.3284**	0.1228	-0.3209**	0.1228
U_RATE	0.2733**	0.0762	0.2697**	0.0762
N	6507		6507	
-2Log L	4134.568		4131.418	
** Significant at the .01 level * Significant at the .05 level Marginal Effect in brackets				

**Table XI. Simple Probit Models for SURVIVE.**

the predictive accuracy of a model. Model 1 predicts with 86.6 percent accuracy whether or not an officer remained on active duty until the O-5 promotion point. Model 2 predicts results with 86.5 percent accuracy. A third measure of goodness of fit is an assessment of whether the signs and significance of the explanatory variables fit with hypothesized relationships.

The results of models 1 and 2 indicate that officers with graduate degrees from any source, NPS degrees and degrees from sources other than NPS are all more likely to survive than officers without any graduate degree at all. The marginal effects indicate the percentage difference in survival rates while holding all other explanatory variables at their mean values. Thus, an officer with a graduate degree from any source (MASTERS) is 12 percentage points more likely to survive than an officer without a graduate degree. Officers with graduate degrees from NPS are 10.5 percentage points more likely to survive than officers without graduate degrees. Those with degrees from sources other than NPS are 12.4 percentage points more likely to survive than officers without graduate degrees. The relative comparison of both NPS and NOT\_NPS to officers without any graduate degree indicates that graduate education from sources other than NPS provides a greater effect on retention to the O-5 promotion point than graduate education from NPS. One should note however, that the non-NPS category includes graduates of the intermediate-level service schools.

Results from Models 1 and 2 indicate that officers with a higher performance index (PINDEX) and more dependents are more likely to survive until the O-5 promotion point. Officers with combat experience, aviators and officers who had been married are

more likely to survive to the O-5 promotion point whereas officers with active-duty enlisted experience and males are less likely to survive.

Based on the literature reviewed in Chapter II, the sign and statistical significance of all of the explanatory variables seem within reason with the possible exception of SEX. After controlling for females' lower performance evaluation indexes and fewer numbers of personal awards, females appear more likely to survive to the O-5 promotion point. It should be noted however, that only 256 (roughly 3 percent) of the 6,507 officers in the Accession Cohort Sample are female.

## **B. PROMOTION MODELS**

The predicted probability of promotion from the Promotion Sample of 1,627 officers is estimated with the simple probit model. The non-linear probit model imposes the restriction that the dependent variable SELECT is bounded by 0 and 1.

Table XII presents the results of alternative specifications of the SELECT model. Models 3 through 5 are estimated with an increasing number of performance indicators in order to evaluate the robustness of the coefficients of the graduate education variables; Model 3 contains none of the performance measures; Model 4 includes AWARDS and PME; Model 5 includes AWARDS, PME and PINDEX.

The results of Model 3 indicate that officers with graduate degrees from any source, aviators and those who were younger at time of commissioning are more likely to be promoted to O-5. According to Model 3, an officer's sex was not a significant factor in promotion to O-5. The marginal effect of MASTERS indicates that officers with graduate education are 21.5 percentage points more likely to be promoted than an officer without a graduate degree.

After adding the performance measures PINDEX, AWARDS and PME in Model 5, the marginal effect of having a graduate degree from any source (MASTERS) decreases from .2157 to .1504. The reduction of the marginal effect of MASTERS is consistent with the notion that its effect was over-stated when the variables AWARDS, PME and PINDEX were omitted. This marginal effect of .1504 indicates that an officer with a graduate degree from any source is 15.04 percentage points more likely to be selected for promotion to O-5 than an officer without a graduate degree. Since the overall promotion rate is .68, a 15 percentage point difference represents a 22 percent promotion advantage for degree holders. Model 5 will serve as the basic structural model for promotion to O-5 (SELECT) throughout the rest of this thesis.

The results of Model 5 indicate that officers who have a higher performance index, a greater number of personal awards, completed their intermediate-level PME, are younger at the time of commissioning and female are more likely to be selected for promotion to O-5. The results also indicate that aviators and those from aviation support MOSs are more likely to be promoted than those from combat arms MOSs. Note that after controlling for performance evaluation index, number of personal awards and PME completion, the effect of being female becomes significant. These results are all consistent with previous research and support the a priori hypotheses.

Variable	Model 3		Model 4		Model 5		Model 6	
	Coeff.	Std.Err.	Coeff.	Std.Err.	Coeff.	Std.Err.	Coeff.	Std.Err.
INTERCEPT	2.3221**	0.5925	1.1495**	0.6231	-21.5945**	2.8319	-21.7892**	2.8342
PINDEX	-----	-----	-----	-----	2.6019**	0.3158	2.6288**	0.3162
AWARDS	-----	-----	0.1051**	0.0166	0.0995**	0.017	0.0975**	0.0171
PME	-----	-----	0.7083**	0.0714	0.7056**	0.0727	0.6887**	0.0735
MASTERS	0.6155** [0.2157]	0.0684	0.4778** [0.1634]	0.0719	0.4443** [0.1504]	0.0734	-----	-----
NPS	-----	-----	-----	-----	-----	-----	0.3151** [0.1065]	0.1114
NOT_NPS	-----	-----	-----	-----	-----	-----	0.4955** [0.1674]	0.0809
COMBAT	0.0916	0.0708	-0.1003	0.0772	-0.0573	0.0788	-0.0616	0.079
PRIENL	0.0119	0.1451	-0.0154	0.1505	-0.0197	0.1534	-0.0052	0.1539
USNA	-0.1271	0.1113	-0.0424	0.1152	-0.0677	0.117	-0.0393	0.1186
NROTC	-0.1788	0.0932	-0.1451	0.0976	-0.1042	0.0998	-0.0982	0.1
SERVICE	-0.1577	0.1414	-0.0381	0.1457	0.0288	0.1484	0.042	0.1487
SUPPORT	-0.1797	0.0928	-0.0942	0.0964	-0.001	0.099	0.0126	0.0995
AVIATOR	0.2402**	0.0913	0.3708**	0.0963	0.4702**	0.0991	0.4685**	0.0992
AVSPPT	0.2675	0.1453	0.3622*	0.1512	0.3820*	0.1531	0.3923*	0.1532
COMM_AG E	-.0783**	0.0219	-0.0623*	0.0228	-0.0700**	0.0233	-0.0721**	0.0234
MARSTAT	0.1049	0.1885	-0.0029	0.1973	0.052	0.2011	0.0509	0.201
DEPEND	0.0073	0.0255	0.0230	0.0263	0.0123	0.0269	0.0125	0.0269
SEX	-0.5083*	0.2153	-0.4768*	0.2219	-0.6214**	0.2273	-0.6067**	0.2273
N	1627		1627		1627		1627	
-2Log L	1906.885		1746.624		1677.018		1674.674	
** Significant at the .01 level * Significant at the .05 level Marginal Effect in brackets								

**Table XII. Simple Probit Models for SELECT**

Measures of goodness of fit for Model 5 indicate that the model is reasonably valid. The log-likelihood ratio (LLR) test indicates that the set of explanatory variables does explain some of the variation in selection to O-5. Also, the model correctly predicts selection to O-5 with 74 percent accuracy.

Model 6 contains the same set of explanatory variables as Model 5 although the variable MASTERS (master's degree from any source) is replaced by the variables NPS and NOT\_NPS to evaluate differences in the effects of graduate degrees from NPS versus from sources other than NPS. The marginal effect of NPS is .1065 and the marginal



effect of NOT\_NPS is .1674. The difference in these marginal effects indicates that graduate degrees from sources other than NPS have a larger effect on promotion to O-5 than graduate degrees from NPS. This outcome is not surprising considering officers who attend NPS typically leave their normal career paths for approximately six years and receive not-observed performance evaluations while attending NPS. Additionally, the variable NOT\_NPS is also representative of officers who received their graduate education from intermediate-level PME schools, which are quite selective in their own right. Completion of either resident or non-resident PME is considered essential for promotion to O-5.

Table XIII includes alternative specifications of the SELECT model, which modify the basic structure of Model 5 and allow for testing of the following null hypotheses:

- There is no difference in selection rates across various fiscal year promotion boards.
- The return to graduate education did not change between the FY1998 through FY2001 O-5 promotion boards.

Model 7 includes the variables FY1999, FY2000 and FY2001 to test the first null hypothesis (FY1998 is the omitted category). Using the LLR test, Model 5 serves as the restricted model and Model 8 serves as the unrestricted model. The following equation is used to determine the chi square statistic ( $\lambda$ ) for the LLR test:

$$\lambda = [-2\text{Log } L (\text{Restricted})] - [-2\text{Log } L (\text{Unrestricted})]$$

At the 95 percent confidence level, the critical test statistic is 7.81 (Chi-Square, 3 df). In this case,  $\lambda = 2.34$  and the first null hypothesis is accepted: There is no significant difference in promotion rates across fiscal years.

Model 8 includes the interaction variables MASTERS\*FY1999, MASTERS\*FY2000 and MASTERS\*FY2001 to test the second null hypothesis (MASTERS\*FY1998 is the omitted case). Model 5 serves as the restricted model and Model 8 as the unrestricted model. The log likelihood ratio test yields a chi-square statistic ( $\lambda$  of -.0184. At the 95 percent confidence level, the critical test statistic is 7.81 (chi-square, 3 df). Thus, the second null hypothesis is also accepted: the effect of a master's degree on promotion does not vary across fiscal years.

### **C. MODELING SAMPLE SELECTION BIAS**

Since the Promotion Sample contains observations of officers who were not randomly selected into the sample, those officers likely possess unobserved characteristics that predict both the likelihood of survival until the O-5 promotion point and promotion to O-5. These unobserved factors could potentially bias the coefficients of the graduate education variables in Models 5 and 6 (as well as the coefficients of other variables).

#### **1. Bivariate Probit with Sample Selection**

When analyzing the effects of various accession characteristics on promotion to the ranks of captain and major, North and Smith (1993) found that the results of their simple probit models for promotion were affected by sample selection bias since those considered for promotion must have first remained on active duty until the promotion point in question. North and Smith (1993) used the bivariate Probit model with sample selection to correct for this bias.

VARIABLES	Model 7		Model 8		Model 9	
	Coeff.	Std.Err.	Coeff.	Std.Err.	Coeff.	Std.Err.
INTERCEPT	-22.0025**	2.9069	-22.0594**	2.8880	-21.7797**	2.8655
PINDEX	2.6555**	0.3268	2.6589**	0.3226	2.5992**	0.316
AWARDS	0.0984**	0.0171	0.0984**	0.0171	0.1000**	0.017
PME	0.6938**	0.0732	0.6956**	0.0729	0.7072**	0.0728
MASTERS	0.4469** [.1513]	0.0735	0.4977** [.1685]	0.1174	0.4406** [.1509]	0.0739
GCT	-----	-----	-----	-----	0.0016	0.0037
COMBAT	-0.0544	0.0791	-0.0565	0.0790	-0.0572	0.0788
PRIENL	-0.0139	0.1534	-0.0173	0.1535	-0.0235	0.1537
USNA	-0.0708	0.1175	-0.0681	0.1171	-0.0779	0.1193
NROTC	-0.1013	0.0999	-0.1024	0.0999	-0.1114	0.1012
SERVICE	0.0314	0.1485	0.0295	0.1487	0.0278	0.1485
SUPPORT	-0.0027	0.0993	-0.0056	0.0991	0.0005	0.0991
AVIATOR	0.4741**	0.0994	0.4675**	0.0994	0.4669**	0.0994
AVSPPT	0.3832*	0.1533	0.3819*	0.1532	0.3836*	0.1532
COMM AGE	-0.0711**	0.0234	-0.0708**	0.0234	-0.0697**	0.0234
MARSTAT	0.0459	0.2009	0.0457	0.2012	0.0485	0.2013
DEPEND	0.0126	0.0269	0.0134	0.0269	0.0122	0.0269
SEX	-0.6238**	0.2274	-0.6317**	0.2280	-0.6240**	0.2275
FY1999	-0.0019	0.1074	-----	-----	-----	-----
FY2000	-0.0192	0.0987	-----	-----	-----	-----
FY2001	-0.0867	0.107	-----	-----	-----	-----
MAST*FY1999	-----	-----	0.0151	0.1528	-----	-----
MAST*FY2000	-----	-----	-0.0531	0.1411	-----	-----
MAST*FY2001	-----	-----	-0.1593	0.1533	-----	-----
N	1627		1627		1627	
-2Log L	1674.674		1677.0364		1676.828	
** Significant at the .01 level * Significant at the .05 level Marginal Effect in brackets						

**Table XIII. Alternative Simple Probit Models for SELECT.**

In order to control for those unobserved factors that predict both retention until the O-5 promotion point and promotion to O-5, this thesis also uses the bivariate probit with sample selection technique to estimate the joint probability of retention and promotion to O-5. This technique requires the joint estimation of a selection model (Model 1) and an outcome model (Model 5) and controls for the covariance of the error terms in both models. Model 1 contains the variable U\_RATE, which serves as an

instrumental variable that is related to survival but not related to selection for promotion to O-5. The basic model is as follows (North and Smith 1993, 32):

$$y_{i1} = \beta_1 x_{i1} + \varepsilon_{i1}, \quad (1)$$

$$y_{i2} = \beta_2 x_{i2} + \varepsilon_{i2}, \quad (2)$$

$$\varepsilon_1, \varepsilon_2 \sim \text{BVN}(0,0,1,1,\rho),$$

**( $y_{i1}, x_{i1}$ ) is observed only when  $y_{i2} = 1$ .**

Where  $y_1$  is equal to the dependent variable for the outcome equation;  $y_2$  is the dependent variable for the selection equation;  $x_{i1}$  is the vector of explanatory variables for the outcome equation;  $x_{i2}$  is the vector of explanatory variables for the selection equation;  $\beta_1$  is the vector of coefficients for the outcome equation;  $\beta_2$  is the vector of coefficients for the selection equation;  $\varepsilon_1$  is the error term for the outcome equation;  $\varepsilon_2$  is the error term for the selection equation.

Tables XIV and XV present the results of the bivariate probit with sample selection models. Model 10 uses MASTERS as a single explanatory variable for graduate education whereas Model 11 distinguishes between graduate education from NPS and sources other than NPS (NOT\_NPS).

The results of Model 10 indicate that graduate education from any source is positively related to the joint probability of survival to the O-5 promotion point and promotion to O-5. The marginal effect of graduate education from any source on survival to the O-5 promotion point is -.0247 and its marginal effect on promotion for those who survived is .1597. The sum of these effects is the overall marginal effect on the joint probability of survival and promotion. When all variables are held at their means, the expected probability of promotion given that an officer survived to the O-5 promotion

Model 10					
Index for SELECT Equation			Index for SURVIVE Equation		
	Coeff.	Std.Err.		Coeff.	Std.Err.
INTERCEPT	-21.5638**	7.4833	INTERCEPT	-36.3745**	1.1007
PINDEX	2.5978**	0.8099	PINDEX	3.9253**	0.1172
AWARDS	0.0990**	0.0162	GPA	0.0010	0.0068
PME	0.7008**	0.0742	MASTERS	1.0550* [-.0247]	0.0509
MASTERS	0.5103* [.1597]	0.1944	COMBAT	0.5084**	0.0504
COMBAT	-0.0315	0.1214	PRIENL	-0.3629**	0.0879
USNA	-0.0880	0.1221	USNA	-0.1856*	0.0760
NROTC	-0.1197	0.1007	NROTC	0.0008	0.0660
SERVICE	0.0065	0.1503	SERVICE	-0.2195*	0.0880
SUPPORT	-0.0009	0.1045	SUPPORT	0.1281	0.0659
AVIATOR	0.4672**	0.1045	AVIATOR	0.2121**	0.0700
AVSPPT	0.3836*	0.1524	AVSPPT	0.0504	0.1027
COMM AGE	-0.0763**	0.0217	COMM AGE	-0.0159	0.0148
MARSTAT	0.0705	0.2445	MARSTAT	0.5777**	0.0948
DEPEND	0.0258	0.0395	DEPEND	0.1734**	0.0149
SEX	-0.6305**	0.2192	SEX	-0.3280**	0.1168
			U RATE	0.2784**	0.0715
N	1627		N	6507	
RHO	0.0964	0.3042			
E[Y1 Y2=1]	0.7589				
** significant at the .01 level					
* Significant at the .05 level					

**Table XIV. Bivariate Probit Model with Sample Selection for the Joint Probability of SURVIVE and SELECT (MASTERS).**

point is .7589. Thus, an officer with a graduate degree from any source is 13.5 percentage points (or 18 percent) more likely to survive and be promoted to O-5 than an officer without a graduate degree. Note this marginal effect of 13.5 percentage points is very close to the marginal effect from the simple probit model for promotion (15.0 percentage points). The measure of correlation between the error terms on both models (rho) is positive but not statistically significant.

The results of Model 11 indicate that graduate education from both NPS and non-NPS sources are positively related to the joint probability of retention to the O-5 promotion point and promotion to O-5. The marginal effects indicate that an officer with a graduate degree from NPS is 8 percentage points (or 10.9 percent) more likely to remain on active duty until the O-5 promotion point and be promoted than an officer without a graduate degree. An officer with a non-NPS graduate degree is 13.5 percentage points (or 17 percent) more likely to both remain on active duty until the O-5 promotion point and be promoted than an officer without a graduate degree. The rho term in this model is positive but not statistically significant.

## 2. Sample Selection Adjustment Using the Heckman Model

Another technique used for controlling selection bias is the Heckman Procedure. It is considered more robust than the bivariate probit model for detecting the presence of selection bias, but it uses linear OLS models to estimate the probability of a binary outcome. Thus, the magnitude of estimated coefficients may be inconsistent and cannot be used for further analysis. In his 1996 NPS thesis, Ronald Wielsma used the Heckman Procedure to correct for selection bias in his analysis of the effects of graduate education on promotion to O-4. As Wielsma attempted to control for the retention issue in his promotion model, he found that the effect of graduate education decreased when he applied this two-stage model.

The general model for the Heckman Procedure is presented as follows (Green 1995, 638):

$$E[y_i|x_i, \text{in sample}] = \beta'x_i + (\rho\sigma_\varepsilon)\lambda_i \quad (3)$$

$$\beta'x_i + \theta\lambda_i. \quad (4)$$

Where  $y$  equals the dependent variable for the outcome equation;  $x$  is equal the vector of explanatory variables in the selection equation,  $\beta'$  is the vector of coefficients in the selection equation and  $\lambda$  is equal to the probability that an observation was selected into the sample.

Model 11					
Index for SELECT Equation			Index for SURVIVE Equation		
	Coeff.	Std.Err.		Coeff.	Std.Err.
INTERCEPT	-22.7598**	7.5363	INTERCEPT	-36.5148**	1.1020
PINDEX	2.7296**	0.8130	PINDEX	3.9399**	0.1175
AWARDS	0.0979	0.0164	GPA	0.0014	0.0068
PME	0.6838**	0.0761	NPS	0.9303**	0.0811
NPS	0.3985*	0.1937		[-.0351]	
NOT_NPS	0.5855**	0.2076	NOT_NPS	1.0972**	0.0569
	[.1763]			[-.0414]	
COMBAT	-0.0244	0.1242	COMBAT	0.5025**	0.0506
USNA	-0.0644	0.1230	PRIENL	-0.3562**	0.0883
NROTC	-0.1096	0.1006	USNA	-0.1739*	0.0764
SERVICE	0.0113	0.1514	NROTC	0.0035	0.0660
SUPPORT	0.0157	0.1058	SERVICE	-0.2185*	0.0878
AVIATOR	0.4703**	0.1038	SUPPORT	0.1359*	0.0660
AVSPPT	0.3907*	0.1523	AVIATOR	0.2115**	0.0701
COMM AGE	-0.0778**	0.0216	AVSPPT	0.0569	0.1037
MARSTAT	0.0829	0.2458	COMM AGE	-0.0166	0.0148
DEPEND	0.0285	0.0406	MARSTAT	0.5780**	0.0947
SEX	-0.6423**	0.2168	DEPEND	0.1743**	0.0149
			SEX	-0.3210**	0.1165
			U RATE	0.2736**	0.0716
N	1627		N	6507	
RHO	0.1455	0.3124			
ME E[Y1 Y2=1]	0.7771				
** significant at the .01 level					
* Significant at the .05 level					
Marginal Effect in brackets					

**Table XV. Bivariate Probit Model with Sample Selection for the Joint Probability of SURVIVE and SELECT (NPS, NOT\_NPS).**

The first stage of the Heckman procedure requires a simple probit model to estimate the probability of survival to the O-5 promotion point (Model 1). Heckman refers to the term  $\lambda$  as “the inverse of Mill’s ratio” and describes it as “a monotone decreasing function of the probability that an observation is selected into the sample

(Heckman 1979, 156).” The estimation of SURVIVE in the first stage is based on the 6,507 observations from the Accession Cohort Sample. The output from this first stage includes  $\lambda$ , which is subsequently used as an explanatory variable in the OLS outcome equation.

This thesis uses Model 5 as the structural model for this second stage outcome model. Estimation of the second stage outcome model is based on the 1,627 observations of the Promotion Sample. This procedure also requires an instrumental variable in the selection equation that is related to retention to the O-5 promotion point but not related to selection for promotion. In this case the instrumental variable is U\_RATE. (Heckman, 1979)

Table XVI presents the LPM results of two alternative Heckman Models for sample selection. Model 12 includes MASTERS as the graduate education variable and Model 13 includes NPS and NOT\_NPS as explanatory variables to distinguish between the effects of graduate education from NPS and sources other than NPS.

The results of Model 12 indicate that the effect of graduate education from any source on selection for promotion to O-5 remains positive and statistically significant. The coefficient of lambda is also positive and significant at the .05 level. This indicates that some bias did exist on the estimates produced in Model 5. While the LPM estimates produced in Model 12 are only a linear approximation of the non-linear probit function, it appears that the marginal effect of MASTERS increased from .1504 in Model 5 to .2295. Consistent with previous research, one would have expected the marginal effect to decrease. All of the statistically significant explanatory variables from Model 12 match the significant variables in Model 5.



	Model 12		Model 13	
	Coeff.	Std.Err.	Coeff.	Std.Err.
INTERCEPT	-10.3676**	2.2394	-10.4704**	2.2535
PINDEX	1.2630**	0.2433	1.2748**	0.2448
AWARDS	0.0259**	0.0045	0.0255**	0.0045
PME	0.2291**	0.0221	0.2246**	0.0224
MASTERS	0.2295**	0.0556	-----	-----
NPS	-----	-----	0.1901**	0.0574
NOT_NPS	-----	-----	0.2434**	0.0579
COMBAT	0.0325	0.0337	0.0309	0.0335
USNA	-0.0358	0.0365	-0.0286	0.0366
NROTC	-0.0386	0.0298	-0.0368	0.0298
SERVICE	-0.0146	0.0473	-0.0113	0.0473
SUPPORT	0.0072	0.0306	0.0107	0.0308
AVIATOR	0.1428**	0.0295	0.1418**	0.0295
AVSPPT	0.1165**	0.0444	0.1201**	0.0445
COMM AGE	-0.0268**	0.0065	-0.0270**	0.0065
MARSTAT	0.0836	0.0701	0.0843	0.0702
DEPEND	0.0203	0.0115	0.0208	0.0116
SEX	-0.2190**	0.0669	-0.2158**	0.0668
LAMBDA	0.1738*	0.0877	0.1756*	0.0879
N Data Set	6507		6507	
N Selected	1627		1627	
** Significant at the .01 level				
*Significant at the .05 level				

**Table XVI. Two-Step Heckman Model Adjustment for Sample Selection: LPM Estimates for SELECT.**

The results of Model 13 indicate that the effects of both NPS and non-NPS graduate education on selection for promotion to O-5 remain positive and statistically significant. Like Model 12, the coefficient of lambda is positive and significant at the .05 level, and the marginal effects of NPS and NOT\_NPS are larger than those found in Model 6. The sign and significance of all coefficients are consistent with those of Model 6.

#### **D. MODELING FOR SELF SELECTION BIAS**

Officers who hold graduate degrees were not randomly selected into graduate education programs; they voluntarily chose to participate and in some cases were

accepted by the Marine Corps to undertake graduate education. Thus, they are likely to possess characteristics, unobserved in Model 5, that are correlated with both possession of graduate education and promotion to O-5. These officers would surely have had a higher probability of being promoted to O-5 regardless of whether or not they obtained graduate degrees. Hence, the estimates in Models 5 and 6 are potentially affected by selection bias.

### **1. Modeling for Graduate Education**

Both of the techniques used for correcting potential self-selection bias require simple probit estimates for the probability of selection to graduate education. Table XVII presents the results of two simple probit models using the binary dependent variable MASTERS. The simple probit models for selection to graduate education are all based on the Promotion Sample.

The results of model 15 indicate that officers with higher GCT scores, higher GPAs at TBS, from the Naval Academy and those who have been married are more likely to undertake graduate education. The results also indicate that aviators are less likely to hold graduate degrees than officers from ground combat arms MOSs. These results are consistent with previous expectations and indicate a reasonable goodness of fit. Additionally, the log likelihood statistic indicates that the set of explanatory variables jointly are significant in explaining the probability of possessing a graduate degree. This model correctly predicts 59.7 percent of the observations.

Variable	Model 14		Model 15	
	Coeff.	Std.Err.	Coeff.	Std.Err.
INTERCEPT	-4.3373**	0.9230	-4.6732**	0.9348
GPA	0.0487** [.0194]	0.0096	0.0395** [.0157]	0.0103
GCT	-----	-----	0.0087* [.0035]	0.0036
USNA	0.4194**	0.1051	0.3632**	0.1077
NROTC	0.1111	0.0889	0.0799	0.0900
SERVICE	0.2690	0.1380	0.2482	0.1385
SUPPORT	0.1470	0.0907	0.1399	0.0909
AVIATOR	-0.3029**	0.0852	-0.3254**	0.0857
AVSPPT	0.1876	0.1332	0.1822	0.1334
COMM AGE	-0.0093	0.0187	-0.0070	0.0187
MARSTAT	0.4022*	0.1848	0.3925*	0.1849
DEPEND	-0.0147	0.0243	-0.0154	0.0244
SEX	-0.0597	0.1924	-0.0643	0.1931
N	1627		1627	
-2Log L	2163.97		2158.038	
** Significant at the .01 level * Significant at the .05 level Marginal Effect in brackets				

**Table XVII. Simple Probit Models for MASTERS.**

Models 16 and 17 in Table XVIII present results of simple probit models for the binary dependent variables NPS and NOT\_NPS, respectively. These models use the same set of explanatory variables as Model 15.

The results of model 16 indicate that officers with higher GCT scores and Naval Academy graduates are all more likely to hold NPS graduate degrees. The results also indicate that officers from SERVICE, SUPPORT and AVSPPT MOS categories are more likely to hold NPS degrees than ground combat arms officers, whereas aviators are less likely to hold NPS degrees. These results are consistent with previous expectations, and this model predicts with 87 percent accuracy.

The results of Model 17 indicate that officers with higher GPAs at TBS and those who have been married are more likely to hold graduate degrees from sources other than NPS. The results also indicate that aviators are less likely to hold non-NPS graduate degrees than those in combat arms MOSs. This model predicts actual observations with only 60.8 percent accuracy. Thus, overall goodness of fit for this model is considered marginal.

A possible explanation for the difference in the coefficients for GPA and GCT between Models 16 and 17 is that selection for NPS is largely based on academic qualification whereas selection for non-NPS programs is based on self selection in the case of the Tuition Assistance Program and military performance in the case of intermediate-level PME institutions. Thus, one might expect GCT to be more positive and significant in the NPS model and GPA at TBS to be more positive and significant in the NOT\_NPS model.

## 2. Bivariate Probit

Bowman and Mehay (1999) used the bivariate probit model to address the issue of selection bias caused by the non-random selection of officers into graduate education programs. They described the model as follows (Bowman and Mehay 1999, 458):

$$Y_i = x_i\beta + I_{Gi}\gamma + \varepsilon_{yi} \quad (5)$$

$$G_i = Z_i\alpha + \varepsilon_{Gi} \quad (6)$$

Where  $I_{Gi}$  is an indicator variable equal to 1 if the individual attends graduate school and equal to 0 otherwise;  $y_i$  is the latent value of being promoted;  $G_i$  is the latent value of completing graduate school;  $x_i$  is a set of individual characteristics and  $Z_i$  includes some of the characteristics in  $x$  plus a set of instruments for graduate school completion.

Variable	Model 16		Model 17	
	Dependent Variable = NPS		Dependent Variable = NOT NPS	
	Coeff.	Std.Err.	Coeff.	Std.Err.
INTERCEPT	-6.1732**	1.2630	-2.5080**	0.9289
GPA	0.0160 [.0028]	0.0141	0.0305** [.0118]	0.0103
GCT	0.0226** [.0040]	0.0049	-0.0024 [.0009]	0.0036
USNA	0.7933**	0.1226	-0.1141	0.1072
NROTC	0.2095	0.1162	-0.0113	0.0877
SERVICE	0.5956**	0.1607	-0.0981	0.1356
SUPPORT	0.4888**	0.1183	-0.1158	0.0940
AVIATOR	-0.3508**	0.1295	-0.2023*	0.0858
AVSPPT	0.5094**	0.1620	-0.0809	0.1319
COMM AGE	-0.0029	0.0252	-0.0030	0.0186
MARSTAT	0.0745	0.2663	0.3751*	0.1896
DEPEND	0.0273	0.0319	-0.0275	0.0245
SEX	0.2514	0.2431	-0.2223	0.1890
N	1627		1627	
2Log L	1103.904		2162.834	
** Significant at the .01 level * Significant at the .05 level Marginal Effect in brackets				

**Table XVIII. Simple Probit Models for NPS and NOT\_NPS.**

Table XIX presents the results of the bivariate probit estimates in which MASTERS, NPS and NOT\_NPS serve as G in Models 18, 19 and 20, respectively, and SELECT serves as Y. Models 18, 19 and 20 are all based on the Promotion Sample of 1,627 observations and use GCT score as an instrumental variable in Z.

In order to identify GCT score an instrumental variable related to possession of a graduate degree but not related to promotion, the following null hypotheses required testing:

- An officer's GCT score is not a significant determinant of promotion to O-5.
- GCT score is not a significant determinant of the decision to pursue graduate education.

Models 5 and 9 both estimate the probability of promotion to O-5; however, Model 9 includes the variable GCT to test the first null hypothesis. Model 5 serves as the

	Model 18		Model 19		Model 20	
Variable	Index for SELECT		Index for SELECT		Index for SELECT	
	Coeff.	Std.Err.	Coeff.	Std.Err.	Coeff.	Std.Err.
INTERCEPT	-18.7468**	2.6888	-19.5599**	2.3605	-16.2136**	3.1413
PINDEX	2.2328**	0.3175	2.3739**	0.2633	1.9153**	0.3732
AWARDS	0.0888**	0.0166	0.0904**	0.0154	0.0745**	0.0165
PME	0.6322**	0.0882	0.6346**	0.0756	0.5331**	0.0983
MASTERS	1.3073** [.5836]	0.3094	-----	-----	-----	-----
NPS	-----	-----	1.4019** [.5328]	0.2804	0.2320* [.1197]	0.0914
NOT_NPS	-----	-----	0.4432** [.1685]	0.0805	1.6183** [.8347]	0.1987
COMBAT	-0.0485	0.0713	-0.0621	0.0731	-0.0484	0.0627
USNA	-0.2035	0.1211	-0.3087*	0.1392	0.0299	0.1062
NROTC	-0.1516	0.0958	-0.1691	0.0980	-0.0833	0.0905
SERVICE	-0.0503	0.1387	-0.1256	0.1442	0.0855	0.1275
SUPPORT	-0.0260	0.0974	-0.0995	0.1029	0.0837	0.0918
AVIATOR	0.5368**	0.0959	0.4931**	0.0979	0.4689**	0.0979
AVSPPT	0.2941	0.1529	0.2388	0.1547	0.3515*	0.1383
COMM AGE	-0.0659**	0.0200	-0.0664**	0.0199	-0.0595**	0.0196
MARSTAT	-0.1057	0.2069	0.0111	0.2065	-0.1462	0.1930
DEPEND	0.0166	0.0249	0.0056	0.0257	0.0248	0.0238
SEX	-0.5579**	0.1989	-0.6533**	0.2061	-0.3890**	0.1936
	Index for MASTERS		Index for NPS		Index for NOT_NPS	
INTERCEPT	-4.9208**	0.9308	-7.0737**	1.2485	-2.9864**	0.8899
GPA	0.0460**	0.0099	0.0303*	0.0142	0.0385**	0.0097
GCT	0.0066	0.0035	0.0199**	0.0046	-0.0032	0.0032
USNA	0.3745**	0.1083	0.8049**	0.1235	-0.1299	0.1076
NROTC	0.0860	0.0909	0.1930	0.1174	-0.0106	0.0902
SERVICE	0.2646	0.1422	0.6203**	0.1546	-0.1158	0.1364
SUPPORT	0.1441	0.0912	0.5153**	0.1173	-0.1037	0.0908
AVIATOR	-0.3195**	0.0855	-0.3257*	0.1402	-0.1970**	0.0863
AVSPPT	0.1823	0.1345	0.5545**	0.1611	-0.0898	0.1341
COMM AGE	-0.0088	0.0190	-0.0047	0.0252	-0.0059	0.0185
MARSTAT	0.3936*	0.1862	0.0655	0.2637	0.3713	0.1947
DEPEND	-0.0151	0.0245	0.0328	0.0311	-0.0264	0.0249
SEX	-0.0771	0.1896	0.2431	0.2338	-0.2763	0.1858
RHO	-0.5801**	0.2204	-0.6525**	0.1733	-0.8029**	0.1776
N	1627		1627		1627	
E[y1 y2=1]	0.5392		0.227		0.3411	
** Significant at the .01 level * Significant at the .05 level Marginal Effect in brackets						

**Table XIX. Bivariate Probit Models for SELECT/MASTERS, NPS,NOT\_NPS.**

restricted model and model 9 serves as the unrestricted model. The LLR test yields a chi-square statistic ( $\lambda$ ) of .19. At the 95 percent confidence level, the critical test statistic is 3.84(chi-square, 1 df). Thus, the first null hypothesis is accepted.

Models 14 and 15 both estimate the probability of selection to graduate education; however, Model 15 includes the variable GCT score whereas Model 14 does not. In order to test the second hypothesis, Model 14 serves as the restricted model and Model 15 as the unrestricted model. GCT score is statistically significant in Model 15 and the chi-square statistic for the LLR test is 5.93. At the 95 percent confidence level, the critical test statistic is 3.84 (Chi-square, 1 df). The second null hypothesis is rejected: GCT score is an important determinant of the decision to pursue graduate education. Thus, GCT score is identified as an acceptable instrumental variable.

The results of Model 18 indicate that graduate education from any source remains positively related to promotion to O-5. The sign and significance of the variables PINDEX, AWARDS, PME, MASTERS, AVIATOR, COMM\_AGE and SEX are consistent with the signs and significance levels of same variables presented in Model 5; however, the marginal effect of MASTERS increased from .15 in Model 5 to .584 in Model 18. An officer with a graduate degree from any source is 58 percentage points (or 108 percent) more likely to be selected for promotion than an officer without graduate education.

The rho term in Model 18 is negative and statistically significant which indicates that the estimates of the simple probit in Model 5 were biased downward. This negative rho term indicates that the unobserved factors that predict both graduate education and selection for promotion are negatively correlated. This outcome is inconsistent with

Bowman and Mehay's (1999) results, which indicated an upward bias on the graduate education variable in their simple probit model. Additionally, the magnitude of the change in the marginal effect of MASTERS from Model 5 to Model 18 seems infeasible. Thus, the results of the entire model should be considered cautiously.

The results of Model 19 indicate that graduate education from both NPS and sources other than NPS is positively related to promotion to O-5 and statistically significant. The marginal effect of NPS increases from .1065 in Model 6 to .5328 in Model 19. This produces the implausible result that an officer with a graduate degree from NPS is 234 percent more likely to be promoted to O-5 than an officer without a graduate degree. The rho term in Model 19 is negative and statistically significant. The magnitude of the change in marginal effect from Model 6 to Model 19 should cause suspicion and such results should be used with caution.

With NOT\_NPS as G, the results of Model 20 indicate that non-NPS graduate education is positively related to selection for promotion to O-5 and statistically significant. The marginal effect of non-NPS graduate education increases from .167 in Model 6 to .8347 in Model 20. Thus, an officer with non-NPS graduate education is 245 percent more likely to be promoted to O-5 than an officer without graduate education. The rho term is again negative and statistically significant. As with the results of Models 18 and 19, the results of Model 20 should also be used with considerable caution since the magnitude of the marginal effect falls outside the realm of plausibility.

### **3. The Heckman Procedure**

In his 1996 NPS thesis, Weilsma also used the Heckman Procedure to control for selection bias that potentially affected his simple probit estimate of the effect of graduate



education on promotion to the rank of O-4 in the Marine Corps. Wielsma found that use of the Heckman Procedure actually reduced the effect of graduate education from that found with his simple probit estimate (as did Bowman and Mehay).

This thesis uses Models 15, 16 and 17 as the first stage selection equations, which predict the likelihood that an officer has a graduate degree from any source, from NPS or from a source other than NPS, respectively. As with the Heckman Procedure for sample selection bias presented earlier, the output of these first stage models includes  $\lambda$ , which will be used as an explanatory variable in second stage promotion models. The second stage models use OLS (linear probability model) to estimate the probability of promotion to O-5, and their results are presented in Table XX.

	Model 21		Model 22		Model 23	
	Adjusted for MASTERS		Adjusted for NPS		Adjusted for NOT NPS	
Variable	Coeff.	Std.Err.	Coeff.	Std.Err.	Coeff.	Std.Err.
INTERCEPT	-6.1167**	0.8509	-6.1534**	0.8513	-6.2272**	0.8670
PINDEX	0.7878**	0.0956	0.8084**	0.0952	0.7758**	0.0951
AWARDS	0.0255**	0.0045	0.0255**	0.0045	0.0241**	0.0045
PME	0.2313**	0.0222	0.2294**	0.0225	0.2256**	0.0227
MASTERS	0.5052**	0.1649	-----	-----	-----	-----
NPS	-----	-----	0.5167**	0.1701	0.0927**	0.0355
NOT NPS	-----	-----	0.1340**	0.0235	1.0958**	0.4218
COMBAT	-0.0131	0.0229	-0.0181	0.0230	-0.0136	0.0228
USNA	-0.0748	0.0457	-0.0946	0.0500	0.0366	0.0546
NROTC	-0.0578	0.0335	-0.0567	0.0321	-0.0363	0.0436
SERVICE	-0.0213	0.0508	-0.0435	0.0523	0.0619	0.0705
SUPPORT	-0.0137	0.0324	-0.0390	0.0344	0.0590	0.0517
AVIATOR	0.1789**	0.0375	0.1465**	0.0304	0.2117**	0.0561
AVSPPT	0.0902	0.0483	0.0729	0.0485	0.1541*	0.0675
COMM AGE	-0.0233**	0.0066	-0.0226**	0.0063	-0.0250**	0.0091
MARSTAT	-0.0526	0.0710	0.0010	0.0630	-0.1273	0.1085
DEPEND	0.0070	0.0088	0.0025	0.0084	0.0155	0.0129
SEX	-0.1759*	0.0687	-0.2052**	0.0671	-0.1001	0.0998
LAMBDA	-0.2373*	0.1027	-0.2343*	0.0931	-0.5962*	0.2614
N	1627		1627		1627	
** Significant at the .01 level						
* Significant at the .05 level						

**Table XX. Selection Adjusted Heckman Models: LPM Estimates for SELECT.**

Model 21 uses MASTERS as the binary dependent variable for the first stage selection model. The results of Model 21 indicate that graduate education from any source is positively related to selection for promotion to O-5 and is statistically significant. With the exception of AVSPPT, all significant variables from Model 5 retained their sign and level of significance in Model 21. Because this second stage LPM model for promotion is a linear approximation of the non-linear probit model, one can roughly compare the coefficients in Model 21 to the marginal effects in Model 18. The size of the coefficient (.505) is fairly consistent with the marginal effect from Model 18 (.583), which again is implausibly large. The lambda term is negative and significant at the .05 level, which indicates the existence of a downward bias on the effect of MASTERS in Model 5.

Model 22 uses NPS as the binary dependent variable in the first stage selection model. The results of Model 22 indicate that graduate education from NPS is positively related to promotion to O-5. With the exception of AVSPPT, all significant variables are consistent with those found in Model 6. As with Model 21, the lambda term is negative and significant at the .05 level, an indication of a downward bias on the NPS coefficient in Model 6. The size of the coefficient for NPS is again too large to be plausible.

Model 23 uses NOT\_NPS as the binary dependent variable in the first stage selection model. The results of Model 23 indicate that non-NPS graduate education is positively related to promotion to O-5. All significant variables are consistent with the sign and significance of those found in Model 6. As with Models 21 and 22, the lambda term is negative and significant at the .05 level, an indication of a downward bias on the

NOT\_NPS coefficient in Model 6. Similar to Models 21 and 22, the coefficient for NOT\_NPS is too large to be plausible.

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## VI. SUMMARY AND CONCLUSIONS

### A. SUMMARY

The results of simple probit models for both retention to the O-5 promotion point and selection for O-5 indicate that the effects of graduate education from any source (MASTERS), graduate education from NPS and graduate education from sources other than NPS (NOT\_NPS) are all positively related to both retention and promotion to O-5.

The results also indicate that graduate education from non-NPS institutions has a greater positive effect on both retention and promotion than graduate education from NPS. Although completion of resident or non-resident intermediate-level PME was included as an explanatory variable in the promotion models, the fact that the NOT\_NPS variable reflects graduate education from intermediate-level PME institutions could still explain why the impact of the non-NPS graduate degree variable is so large.

While indicating positive returns on graduate education from all categories, the results of bivariate probit models with sample selection (due to stay-leave decisions) produced implausibly large coefficients on the graduate education variables. This could indicate that the bivariate probit system was not correctly specified. Thus, the selection-adapted results should be used with caution.

The Heckman models to adjust for sample selection indicated that an upward bias did exist on the coefficients of the graduate education variables in the simple probit estimates for promotion; however, the effects of graduate education from all three categories remained positive and statistically significant.

While indicating positive returns on graduate education from all three categories, the size of the estimated coefficients for the graduate degree variables in the bivariate probit models for promotion to O-5 and selection for graduate education seem implausible and should be considered with caution. A possible explanation for these inconclusive results is that the first-stage simple probit estimates for the likelihood of holding a graduate degree were poorly specified to begin with and thus provided poor predictive power. Identification relies on the use of instrumental variables in the selection equation that can be safely omitted from the outcome equation. Unfortunately, it is difficult to identify and obtain data on factors that predict graduate education that are also not related to retention or promotion.

The results of the Heckman models for promotion and selection to graduate education indicate that the effects of graduate education from all three categories are positively related to promotion to O-5 and statistically significant. Their negative and significant lambda terms indicate that a downward bias did exist on the effects of graduate education in the simple probit estimates for graduate education.

Table XXI presents the marginal effects for the three graduate education categories on retention and promotion to O-5 based on the results of the simple probit models. In the absence of more complete data to address potential selection bias, the marginal effects presented in Table XXI should be considered the most likely estimates.

	ANY MASTERS	NPS	NOT NPS
SURVIVE	.120	.106	.125
SELECT	.150	.107	.167

**Table XXI. Marginal Effects of Graduate Education on SURVIVE and SELECT.**

## **B. CONCLUSIONS**

Positive returns on graduate education are indicative of a "win-win" outcome for both the individual officer and the Marine Corps. The career-minded officer who chooses to participate in the Marine Corps' graduate education programs can look forward to a long, secure career and anticipate a greater chance of promotion to O-5. The Marine Corps can expect a longer period over which it can recoup its investment in the officer, and receives officers from the graduate education programs who are more productive. Thus, the individual career-minded officer has an incentive to participate and the Marine Corps has an incentive to support its graduate education programs.

The results of this thesis should help alleviate perceptions that graduate education programs are only beneficial to officers considering employment outside the Marine Corps. The results should also alleviate perceptions that participation in graduate education programs will hurt an officer's prospects for promotion to higher ranks.

The results of the bivariate probit models for self selection for graduate education and the Heckman Models indicate that the unobserved factors, which predict both graduate education and promotion to O-5 are negatively related. In addition to factors such as time spent in the Fleet Marine Force, time spent in an officer's primary MOS and unobserved performance evaluations, these factors might include subjective qualities such as work ethic, absolute loyalty to the Marine Corps, leadership ability, propensity for academics and taste for the military. These subjective qualities could possibly contribute to any negative perceptions that currently exist regarding the Marine Corps' graduate education programs.

While negative perceptions of the Marine Corps' graduate education programs appear to be false, they still pose a danger of becoming a self-fulfilling prophecy. If individual officers base their decisions to participate on these false perceptions, the Marine Corps will naturally end up with a pool of less select officers who choose to pursue graduate degrees and in time, empirical research will indicate that the effects of graduate education are indeed negative.

### **C. LIMITATIONS**

The primary limitations of this thesis are a result of insufficient data. The inclusion of graduate education from PME institutions in the NOT\_NPS category could be a dominant factor in results that indicate non-NPS graduate education has a greater positive effect on both retention and promotion than graduate education from NPS. Data to support an additional category for graduate education from PME institutions could validate this notion. Nevertheless, these findings should not be used for policy decisions regarding the relative efficiency of NPS versus non-NPS graduate education.

Bivariate Probit models for sample selection were not adequately specified. Additional instrumental variables that are related to retention but not related to promotion could improve model specification and provide more accurate estimates of the effect of graduate education on retention of Marine officers.

The bivariate Probit results for self-selection are considered infeasible since the magnitude of the effects of graduate education on promotion becomes so large. Data elements that better predict whether an officer possesses a graduate degree while unrelated to promotion would likely correct this problem.



#### **D. RECOMMENDATIONS**

Two primary recommendations result from this thesis. The first is that the following data elements be collected for more thorough analysis of the effect of graduate education on retention and promotion of Marine Officers:

- Graduate education from the intermediate-level PME institutions
- The amount of time spent in the Fleet Marine Force over the course of a career
- The amount of time spent in an officer's primary MOS over the course of a career
- Undergraduate GPA
- Data on subsequent promotion boards and corresponding accession cohorts

The second recommendation is that the Marine Corps should continue to emphasize the value and importance of its graduate education programs. Perceptions based on fact or fiction tend to affect decisions made at the individual level. The Marine Corps' continued emphasis on these programs will contribute to their effectiveness and the combat readiness of the Marine Corps well into the future.

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# APPENDIX A. MARINE CORPS FITNESS REPORT

## USMC FITNESS REPORT

U.S. GOVERNMENT PRINTING OFFICE: 1985-548-380

USMC FITNESS REPORT (1610)		ALIGNMENT LINE	
MAYMC 10836 (Rev. 2-86) 5th EDITION (2008-07-11) UP TO 100 (Previous editions will not be used)		REF: MCD P610.7	
<div style="display: flex; justify-content: space-between;"> <div style="width: 30%;"> <b>PROGRAM</b> 1. ORGANIZATION a. MCC b. RUC 2. MARINE REPORTED ON a. LAST NAME b. FIRST NAME c. M.I. d. GRADE e. IDENTIFICATION NO. f. PHOS g. STATUS </div> <div style="width: 70%;"> <b>3. OCCASION AND PERIOD COVERED</b> a. OCC b. PERIOD: FROM-TO c. TYPE d. PERIODS OF NONAVAILABILITY (30 or more consecutive days)-EXPLAIN </div> </div>			
<div style="display: flex; justify-content: space-between;"> <div style="width: 60%;"> <b>4. DUTY ASSIGNMENT</b> a. DESCRIPTIVE TITLE b. MONTHS c. T/O NO. d. LINE NO. e. DUTIES </div> <div style="width: 40%;"> <b>5. SPECIAL INFORMATION</b> a. QUALIFICATION b. REVIEWING OFFICER ID NO. </div> </div>			
<div style="display: flex; justify-content: space-between;"> <div style="width: 60%;"> <b>6. RESERVED FOR FUTURE USE</b> </div> <div style="width: 40%;"> <b>7. RESERVED FOR FUTURE USE</b> </div> </div>			
<b>9. DEPENDENTS REQUIRING TRANSPORTATION</b> a. NO. b. LOCATION c. ADDRESS			
<b>10a. DUTY PREFERENCE (Code)</b> 1st 2d 3d <b>10b. DUTY PREFERENCE (Descriptive Title)</b> (Abbreviate as required) 1st 2d 3d			
<b>11. REPORTING SENIOR</b> a. SERVICE b. GRADE c. IDENTIFICATION NO. d. NAME AND DUTY ASSIGNMENT			
<div style="display: flex;"> <div style="width: 30%;"> <b>12. SPECIAL CASE (Mark if applicable)</b>  <input type="checkbox"/> NOT OBSERVED  <input type="checkbox"/> EXTENDED REPORT  <b>13. PERFORMANCE</b>            13a. REGULAR DUTIES            13b. ADDITIONAL DUTIES            13c. ADMINISTRATIVE DUTIES            13d. HANDLING OFFICERS (MARINE MCO's "NOT")            13e. HANDLING ENLISTED PERSONNEL            13f. TRAINING PERSONNEL            13g. TACTICAL HANDLING OF TROOPS            13h. QUALITIES            13i. ENDURANCE            13j. PERSONAL APPEARANCE            13k. MILITARY PRESENCE         </div> <div style="width: 30%;"> <b>14. ATTENTION TO DUTY</b>            14a. COOPERATION            14b. INITIATIVE            14c. JUDGMENT            14d. PRESENCE OF MIND            14e. FORCE            14f. LEADERSHIP            14g. LOYALTY            14h. PERSONAL RELATIONS            14i. ECONOMY OF MANAGEMENT            14j. GROWTH POTENTIAL         </div> <div style="width: 40%;"> <b>15a. YOUR ESTIMATE OF THIS MARINE'S "GENERAL VALUE TO THE SERVICE"</b>            15b. DISTRIBUTION OF MARKS FOR ALL MARINES OF THIS GRADE:            15c. FILL BOXES SO THAT THE SUM OF EACH COLUMN CORRESPONDS TO ITEM 15b.            16. CONSIDERING THE REQUIREMENTS OF SERVICE IN WAR, INDICATE YOUR ATTITUDE TOWARD HAVING THIS MARINE UNDER YOUR COMMAND:  <input type="checkbox"/> NOT OBSERVED <input type="checkbox"/> PREFER NOT <input type="checkbox"/> BE WILLING <input type="checkbox"/> BE GLAD <input type="checkbox"/> PARTICULARLY DESIRE            17. HAS MARINE BEEN THE SUBJECT OF ANY OF THE FOLLOWING REPORTS? IF YES, REFERENCE IN SECTION C.            a. COMMENDATORY <input type="checkbox"/> YES <input type="checkbox"/> NO b. ADVERSE <input type="checkbox"/> YES <input type="checkbox"/> NO c. DISCIPLINARY ACTION <input type="checkbox"/> YES <input type="checkbox"/> NO            18. REPORT BASED ON OBSERVATION <input type="checkbox"/> DAILY <input type="checkbox"/> FREQUENT <input type="checkbox"/> INFREQUENT <input type="checkbox"/> NOT APPLICABLE <input type="checkbox"/> YES <input type="checkbox"/> NO            19. QUALIFIED FOR PROMOTION <input type="checkbox"/> YES <input type="checkbox"/> NO            20. RECOMMENDATION FOR NEXT DUTY (CONCISE ITEM 14)            21. RESERVED FOR FUTURE USE         </div> </div>			
<b>RECORD A CONCISE APPRAISAL OF THE PROFESSIONAL CHARACTER OF MARINE REPORTED ON. THIS SPACE MUST NOT BE LEFT BLANK.</b>			
<div style="display: flex;"> <div style="width: 50%;"> <b>22. I CERTIFY the information in section A is correct to the best of my knowledge.</b>            *            (Signature of Marine reported on) (Date)  <b>24. (Check one when required) I HAVE SEEN THIS COMPLETED REPORT AND</b>  <input type="checkbox"/> I HAVE NO STATEMENT TO MAKE <input type="checkbox"/> I HAVE ATTACHED A STATEMENT.            (Signature of Marine reported on) (Date)         </div> <div style="width: 50%;"> <b>23. I CERTIFY that to the best of my knowledge and belief all entries made herein are true and without prejudice or partiality.</b>            (Signature of Reporting Senior) (Date)  <b>25. REVIEWING OFFICER (Name, Grade, Service, Duty Assignment)</b>            25a. INITIALS            25b. DATE         </div> </div>			

STAPLE ADDITIONAL PAGES HERE

MARINE REPORTED ON (Last name) (First name) (M.I.)	GRADE	IDENTIFICATION NO.	PERIOD (From) (To)	OCCASION
--	-------	--------------------	--------------------	----------

REPORTING SENIOR'S CERTIFICATION

I certify that on the terminal date shown in Item 3 of Section A, I was the Reporting Senior for only those Marines of the same grade as shown in Item 15b of Section B. Those Marines are ALPHABETICALLY LISTED below. I rank this Marine as \_\_\_\_\_ of \_\_\_\_\_ (only rank Marines marked Outstanding in 15a and b; mark NA if not applicable).

NAME (Last, First, M.I.)	PMOS	NAME (Last, First, M.I.)	PMOS
--------------------------	------	--------------------------	------

SIGNATURE \_\_\_\_\_ DATE \_\_\_\_\_

REVIEWING OFFICER'S CERTIFICATION

1. ☐ I have not had sufficient opportunity to observe this Marine, so I have no comment.
2. ☐ I have had only limited opportunity to observe this Marine, but from what I have observed I generally concur with the Reporting Senior's marks in Items 15a and b.
3. ☐ I have had sufficient opportunity to observe this Marine, and concur with the Reporting Senior's marks in Items 15a and b.
4. ☐ I have had sufficient opportunity to observe this Marine, and do not concur with the Reporting Senior's marks in Items 15a and b. I would evaluate this Marine as \_\_\_\_\_ (Item 15a) and rank this Marine as \_\_\_\_\_ of \_\_\_\_\_ (only rank those evaluated as Outstanding (OS)).

REMARKS (mandatory if Item 4, above, is checked):

SIGNATURE \_\_\_\_\_ DATE \_\_\_\_\_

NOTE: The information above WILL NOT be entered into any computer program.

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